Hydraulic Turbine Contract
and Specifications
For
RIO NEGRO DEVELOPMENT
Between RIONE and S. MORGAN SMITH CO.

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~~U-I~~

ADDENDUM NO. 1

May 28, 1943

CONTRACT BETWEEN THE

COMISION TECNICA Y FINANCIERA DE LAS OBRAS HIDROELECTRICAS DEL RIO NEGRO (RIONE), URUGUAY

and

S. MORGAN SMITH COMPANY

Dated January 11, 1943

All references are to paragraphs and pages of "Engineering Specifications."

1. Paragraph 2, item (f), page 3: Change the estimated weight of complete runner assembly to be lifted by the powerhouse crane from "368,000" to "258,000" lbs.

2. Paragraph 13, page 20: Change the 3rd sentence to read: "It shall be so arranged as to permit not less than 1/4 inch nor more than 5/16 inch vertical movement . . ."

3. Paragraph 25, page 35: Delete the following turbine spare parts:

" 4 - Wicket gates and stems completely machined
4 - Gate stem levers
1 Set - Gate stem bearing bushings
3 - Oil strainer screens "

4. Paragraph 33, item (6), page 44: In 2nd line of item, change "pounds per square inch" to "kilograms per square centimeter."

5. Paragraph 45, page 57: Delete the following governor spare parts:

" (c) 1 - Complete governor head, including motor stator and rotor.

(e) 1 - Governor-head-drive generator stator and bearings "

Also re-letter remaining items to suit.

RIONE REPRESENTATIVE

By Juan Rezzano

Juan C. Rezzano

HARZA ENGINEERING COMPANY

By L F Harza

L. F. Harza

Harza Engineering Company
205 West Wacker Drive
Chicago, Illinois

JLS:MJ

CONTRACT BETWEEN THE COMISION TECNICA Y FINANCIERA DE LAS OBRAS HIDROELECTRICAS DEL RIO NEGRO (RIONE), URUGUAY.

AND

S. MORGAN SMITH COMPANY

This contract is entered into this 11th day of January 1943, by the COMISION TECNICA Y FINANCIERA DE LAS OBRAS HIDROELECTRICAS DEL RIO NEGRO, URUGUAY, an official agency of the Uruguayan Government hereinafter called the "Purchaser", and S. MORGAN SMITH COMPANY, a company organized and existing under the laws of the State of Pennsylvania hereinafter called the "Contractor."

1 - PURPOSE OF THE CONTRACT

ART. 1. The purpose of this contract is the designing, manufacture, supply, sale and delivery of the equipment defined and set forth in detail in the attached specifications dated November 6, 1942 which shall be an integral part of a generator unit, a transmission line, transformer stations at both ends and equipment belonging thereto, in connection with the Rio Negro, Uruguay, project.

In view of the fact that some time will elapse before the War Production Board of the United States will be able to allocate materials and a place in the manufacturing schedule for the manufacture of the equipment included in this contract, it is agreed that neither party hereto need take any action under the provisions of this contract until the Contractor notifies the Purchaser that the War Production Board has taken such action with respect to making available materials and a place in the Contractor's schedule as will enable the Contractor to complete the manufacture of the equipment within the time specified in Article 10. Unless the Contractor notifies the Purchaser within 90 days from the date of signature by the last signing party hereto that such action has been taken by the War Production

Board, this contract shall become null and void unless the parties hereto extend such 90 days period by mutual agreement.

The date for completion of manufacture specified in Article 10 shall be extended by the period in the preceding paragraph during which the parties need take no action.

ART. 2. The obligations of the Contractor shall be governed by the provisions of this contract and the attached specifications.

ART. 3. The Contractor shall prepare and submit for approval to the Purchaser or its designated representative, four blueprints comprising outline or arrangement drawings giving therein such dimensions, weights and informations as may be necessary for the installation and lay-out of the plant. It shall likewise prepare and submit for the approval of the Purchaser or its designated representative the assembly drawings necessary for the installation of the equipment and to clearly show that all the parts of the equipment to be supplied will conform with the provisions and the intent of the specifications.

ART. 4. The Purchaser must either approve or disapprove the plans within a period of ten days. In case of disapproval, the Contractor shall without expense to the Purchaser make all the modifications necessary so that the equipment may be in accordance with the provisions and the intent of the specifications.

ART. 5. The approval of the drawings by the Purchaser or its designated representative does not imply the exemption of the Contractor from any part of its obligation to comply with all the requirements of the specifications, nor shall it in any way exempt from responsibility in connection with the correctness of the drawings.

ART. 6. The Contractor shall make in the drawings and specifications the changes which the Purchaser may demand if in the opinion of the Contractor such changes are not incompatible with the proper operation of the equipment but such changes shall be made at the expense of the Purchaser unless made pursuant to Article 4.

ART. 7. The action, which, in accordance with the provisions of Articles 3, 4, 5 and 6, is incumbent upon the Purchaser or its designated representative shall be exercised by the Consulting Engineer of the Purchaser, such Consulting Engineer at present being the Harza Engineering Company of Chicago, Illinois, (hereinafter called the "Consulting Engineer").

ART. 8. If as a result of the changes mentioned in Article 6 there results an increase or decrease in the price of the equipment, the contract shall be modified in writing by mutual agreement. However, the Purchaser may order, in case the parties do not agree on the change in price, that the manufacture of the equipment should not be withheld or delayed and the question concerning the changed price shall be decided by the Board of Arbitration in accordance with the provisions of Article 32 of this contract. In such case, if there is any increase, the payment provisions of this contract shall be changed to properly reflect such increase and to provide for such increase as if it had been included in the contract at the time of its signature.

ART. 9. The Contractor shall supply to the Purchaser:

(a) A Van Dyke Negative of each one of the drawings approved in accordance with the preceding articles; four blueprints of each one of the tracings of the drawings approved; one complete set of photolithographs (reproduced tracings) of all these drawings;

(b) A Van Dyke Negative, three blueprints and one photolithograph (reproduction of the tracing) of all the drawings which may be reasonably necessary for the assembling, installation and maintenance of the equipment to be supplied under this contract, it being understood that there shall not be supplied any manufacturing drawings or any support structure drawing; and

(c) Complete instructions and information concerning the equipment, its assembly, installation, operation and repair, to the extent to which the Contractor is in the habit of supplying same to its customer.

ART. 9A. The Purchaser or its Consulting Engineer shall furnish to the Contractor such information as may reasonably be required to produce properly designed and manufactured equipment. The parties agree that the Contractor shall not be responsible (a) for the net effective heads of water under which the equipment will operate, (b) for the elevations of head and tail water, (c) for the quantity of and kind of water available to operate the equipment, (d) for the dimensions of equipment now installed at the site to which the Contractor is required to match up the equipment to be furnished under this contract, (e) for the lines, levels, and grades to which the equipment is to be installed in the field, and (f) for the exactness, correctness and completeness of information given to the Contractor by the Purchaser or its Consulting Engineer.

II - TIME OF DELIVERY

ART. 10. The Contractor shall have completed ready for shipment from its factory within 18 months from the date that this contract is signed by both parties, all the equipment which is the subject matter of this contract.

ART. 11. If the Contractor refuses or fails to complete the equipment within the period of time specified in Article 10 as the same may be extended pursuant to Article 1 but in the absence of force Majeure the Purchaser may by written notice to the Contractor terminate this contract pursuant to the provisions of Article 29. The contract shall, subject to the provisions of Article 30 and 31 be extended for causes for force majeure which are defined as any unforeseeable causes beyond the control and without the fault or negligence of the Contractor including but not restricted to Acts of God or of the public enemy, acts of the Government (including but not restricted to any preference, priority or allocation order or the lack of such order), acts of another contractor in the performance of a contract with the United States Government, fires, floods, epidemics, quarantine, restrictions, strikes, freight embargoes, unusually severe weather, delays on the part of the Purchaser or its representative in carrying out inspection and tests or in approving the drawings, or because of changes requested by the Purchaser, pursuant to Article 6, or delays of sub-contractors due to such causes.

ART. 12. The Contractor shall prepare and supply to the Purchaser six copies of a completion schedule showing a breakdown of the complete equipment into its various shipment units, showing the approximate dimensions and weights and the respective dates on which it is estimated units will be completed and ready for shipment from the factory. In the preparation of the said list, the Contractor shall take into consideration the order, in which the parts of the equipment will be necessary for the normal assembly (erection) of same in Uruguay. The Contractor shall give immediate advice to the Consulting Engineer, in writing, in triplicate, of any delay which may be expected in connection with the dates set forth in the said completion schedule, explaining the reason for such delay.

ART. 13. In order to facilitate the steps to be taken in connection with the shipment by the Purchaser, the Contractor shall deliver in triplicate to the Consulting Engineer, once every month, namely about the first of each month, a report on the progress made, showing the following:

(1) The status of completion of the major items of the various assembled equipment and the completion schedule for such items.

(2) The estimated dates within the following 30 days on which any of the parts of the equipment constituting a complete unit to be shipped, will be packed, boxed or crated for transportation by ocean shipment. The date for the submission of the reports mentioned herein and the dates specified herein shall be approximate.

(3) The Contractor shall furthermore supply to the Purchaser once every three months the information necessary for the preparation of a report which must be submitted to the Export-Import Bank of Washington in compliance with an agreement existing between the Government of Uruguay and the Export-Import Bank of Washington, dated July 22, 1942.

III - EXTRAS

ART. 14. If the Purchaser should order any extra or additional equipment from the Contractor and should specify this in a written order accepted by the Contractor, such extra or additional equipment shall be supplied by the Contractor in accordance with the terms and conditions contained in this contract. The Purchaser shall take the necessary steps for the payment of same under conditions similar to the conditions provided for in this contract.

IV - OPTION

ART. 15. The parties declare that they know that under date of April 21, 1942, an agreement was signed by and between the Republic of Uruguay and the United States of America and that in Article 2 of Part II of the said agreement it was stipulated that the Government of Uruguay agrees to grant the manufacturers in the United States an option valid up to September 1, 1942, for the construction of the three remaining turbine and generator units and for the second transmission line and the other equipment necessarily connected therewith in order to complete the final project of the hydroelectric works of the Rio Negro.

In view of the foregoing agreement the parties agree that if the Purchaser decides to purchase turbine parts or governors for such additional units, the following obligations vis-a-vis each other shall apply:

The Purchaser agrees that as, and when it orders turbine parts or governors for such additional units, it will place such orders on the Contractor provided that the Contractor's prices for such additional units do not exceed the U.S. ceiling prices then in effect and are no higher than would be charged to the Government of the United States of America or any of its agencies for such equipment and provided that the Contractor's prices, deliveries, and contract terms and conditions are competitive with those of other comparable manufacturers in the United States of America and provided further that the equipment to be supplied under the terms of this contract has not operated unsuccessfully, and provided that the Contractor is not in default under the provisions of this contract.

V. - INSPECTION AND TESTS

ART. 16. Unless otherwise agreed all equipment and workmanship shall be subject to inspections and tests by such agency of the United States Government as may be selected by mutual agreement between the United States and Uruguayan Governments. The representative of such agency of the United States shall in making such inspection be deemed to be acting on behalf of the Purchaser and the selection of the agency to conduct such inspection shall be arranged by the Purchaser or its Government with the United States Government. The Purchaser may reject equipment which contains defective material or workmanship as advised by the inspectors of the United States agency selected and in case of such rejection the Contractor shall correct the defect or replace the defective part at its own cost. The expense of such inspector shall not be for the account of the Contractor; but the Purchaser may charge to the Contractor the actual additional cost, if any, of such inspector's time, living and traveling expenses incurred in connection with such inspection should any equipment in respect to which notification of readiness for inspection has been given not be ready for inspection at the time specified by the Contractor.

ART. 17. Inspections and tests shall be made in such manner as not to interfere with or retard manufacture of the equipment.

ART. 18. The representative designated by the Export-Import Bank of Washington shall be permitted to inspect the progress of the manufacture of the equipment included in this contract up to the extent required by the agreement signed on July 22, 1942, between the Government of Uruguay and the Export-Import Bank of Washington.

ART. 19. The Contractor will permit the Purchaser's representative (not more than two at any one time) to visit its factories from time to time to the end that they may become familiar with the equipment to be supplied hereunder for the purpose of enabling them to install, operate and maintain the equipment at the site of its installation - all subject to permission for such visits being obtained by the Purchaser from the necessary authorities in the United States.

ART. 20. The inspection does not exclude the responsibility specified in Article 9A or Article 28 of the Contract.

VI - RESPONSIBILITY FOR LOSSES, DAMAGES AND DETERIORATION.

ART. 21. The Contractor is responsible for any losses, damages and deteriorations which may occur in connection with the equipment up to delivery FAS vessel New York irrespective of the cause thereof. Beginning with the moment of delivery the Purchaser shall bear such responsibility. However, the responsibility of the Contractor shall continue for any losses which are the consequence of errors or defects of material, workmanship, packing and/or operation in accordance with what is specified in Article 28.

VII - PRICE

ART. 22. For the complete equipment delivered FAS vessel New York the Purchaser shall pay the price of Four Hundred Seventy Seven Thousand, Four Hundred Ninety Five ($477,495.00) Dollars, Legal Tender of the United States of America.

ART. 23. The price shall be paid as follows:

5% of the total purchase price, namely, the amount of $23,874.75 within 20 days from the expiration of the dormant period specified in Article 1, deducting from this amount what may have already been paid by virtue of the provisional order dated April 26, 1942 issued in favor of the Contractor.

15%, namely the amount of $71,624.25 after 25% of the work has been done,

20%, namely the amount of $95,499.00 after 50% of the work has been done,

20%, namely the amount of $95,499.00 after 75% of the work has been done,

30%, namely the amount of $143,248.50 upon delivery FAS vessel New York or substitute delivery specified in Article 10.

10%, namely the amount of $47,749.50 after field tests and acceptance by the Purchaser in Uruguay but in any event within 18 months after the due date of the 30% payment. Field tests are to be made promptly after the equipment is put into operation. Contractor shall furnish a bond valid for the unexpired period of the twelve (12) or eighteen (18) months (as the case may be) specified in Article 28, in the amount of 10% of the Contract price to cover its repair and replacement warranty as specified in Article 28, in case said 10% payment is made prior to the expiration of said 18 months period.

ART. 24. The price to which reference is had in the foregoing article 22 shall be decreased, in case it should exceed either in whole or in part the maximum price fixed by the Government of the United States, to such an extent that such maximum price shall not be exceeded.

ART. 25. The price to which reference is had in Article 22 shall be adjusted as set forth below:

In order to arrive at a fair adjustment of the Purchase price herein established in the event that the costs of labor and material should either increase or decrease to a considerable extent on account of the abnormal conditions prevailing at the present time, the parties agree that the Purchase price established shall be subject to an adjustment as follows:

a) Labor.

1) For the purposes of this adjustment the proportion of the Purchase price representing labor is fixed at 40%, namely $190,998.00.

2) The above amount having been accepted as representing labor shall be adjusted, in case of a change in the cost of labor, such adjustment to be made on the basis of the index for average wages per hour in the engine, turbine, water-wheel and wind-mill industry, compiled every month by the Department of Labor of the United States of America, Bureau of Labor Statistics. There shall be computed an average of the figures of the said monthly index of labor during the period starting and including the month of April 1942 up to and including the actual date of completion of the equipment at the Contractor's plant and the increase or reduction of the percentage shall be obtained by a comparison with the Labor Index for the month of April 1942. The adjustment for modifications of the cost of labor shall be made by applying such increase or reduction percentage to the cost of labor determined under a) 1) and the result shall be accepted as increase or reduction respectively of the Purchase price to the extent indicated in sub-paragraph c) 5) of this Article.

b) Material.

1) For the purpose of this adjustment, the proportion of the purchase price represented by the materials is fixed at 30%, namely $143,248.50.

2) The foregoing amount accepted as representing the materials shall be adjusted, in case of a change of the costs of material, basing such adjustment on the wholesale price index of the "Metal and

Metal Products Group" compiled by the Department of Labor of the United States of America. There shall be computed an average of the figures of the said monthly index for materials during the period starting and including the month of April 1942 until the actual date of completion of the equipment at the Contractor's plant, and the increase or reduction of percentage shall be obtained by comparison with the index for materials for the month of April 1942. The adjustment for changes in the cost of material shall be obtained by applying such percentage of increase or reduction to the amount of the cost of materials determined under b) 1) and the result shall be accepted, as an increase or reduction respectively, of the purchase price to the extent indicated in sub-paragraph c) 5) of this Article.

c) General Remarks

1) The adjustment to which the Contract price is subject shall be determined in accordance with what has been established above but in the event that there shall be any change in the equipment to be supplied, resulting in a change of the purchase price, then the adjustment shall be modified accordingly taking into consideration the date on which the change was made.

2) When determining the adjustment in the purchase price, the percentage of increase or reduction in the cost of labor and materials shall be calculated up to the nearest 10th of 1%.

3) When computing the averages mentioned in the foregoing subsections a) and b), the month in which the equipment is completed shall be considered as a complete month.

4) If for any reason the indices compiled by the United States Department of Labor, and referred to above, are not available for use in

connection with adjustment in the purchase price, or if the base used in any of such indices is substantially changed during the period for which the calculation hereunder apply, then the parties to this contract will select substitute indices by mutual agreement.

5) The equipment to be purchased by virtue of the present contract shall be invoiced and paid for on basis of the purchase price. In case it should be necessary to make an adjustment in the purchase price under this article, such adjustment shall be determined within a period of 75 days after the completion of the equipment in the Contractor's plant and the party to this contract who shall benefit from this adjustment shall receive in payment from the other party, 90% of the amount of such adjustment within the said period of 75 days and 10% of the said adjustment shall be paid jointly with the final payment to be made by virtue of this contract. The payment to be made by virtue of this paragraph 5), if any, shall be considered as rejected by the party entitled to receive it if, as a result of the combination of adjustments to be made by virtue of the provisions of the foregoing sub-sections a) and b), the resulting total should be less than 5 (five) percent of the total purchase price established in this contract, or as the case may be, as a result of the changes which may be made in the contract from time to time due to an increase or reduction or change in the equipment to be supplied. If such total either upward or downward exceeds such five (5) percent, then payment to either party (as the case may be) for such excess above such 5% shall be made as provided in this paragraph 5). The final price resulting from this adjustment shall in no case exceed the maximum price established by law and prevailing at the time the equipment is completed at the factory.

VIII - CERTIFICATES OF PAYMENT.

ART. 26. The 15% and two 20% payments specified in Article 23 shall be made against presentation of work progress certificates issued by the inspectors appointed pursuant to Article 16. The 30% payment shall be made against presentation of dock receipt, inland bill of lading, storage or warehouse receipt or other evidence of shipment or delivery. The 10% payment shall be made against presentation of certificate of acceptance issued and signed by the Purchaser, which will be issued after successful field tests, but in any event within 18 months after the due date of the 30% payment; it being understood that if at the expiration of such 18 months the equipment does not comply with the warranties specified in Article 28, then said 18 months will be extended until the Contractor completes such changes as may be necessary for such compliance.

To the extent that any document to be issued by the Purchaser or his representative is required to be presented for any payment under this contract, there can be substituted for such document an arbitration award rendered by the Board of Arbitrators pursuant to Article 32 stating that the Contractor is entitled to receive such document.

IX - LETTER OF CREDIT

ART. 27. In order to provide for the payments to be made by the Purchaser hereunder, the Purchaser shall cause to be confirmed in favor of the Contractor by The Guaranty Trust Company of New York within 20 days after the expiration of the dormant period specified in Article 1, an irrevocable letter of credit in United States Dollars to be availed of on or before December 31, 1944 upon terms in conformity with the terms of payment provided in Article 23 with respect to the 5% payment, the 15%

payment, the two 20% payments and the 30% payment, and also the letter of credit shall include terms in conformity with Articles 30 and 31, in the event of cancellation of this contract pursuant to the provisions of said Articles 30 and 31. Such letter of credit shall cover 90% of the purchase price of the equipment included in this agreement., Simultaneously, a second letter of credit with the same bank will be confirmed for 10% of the Purchase price available up to June 30, 1946, as security for the final payment. This second letter of credit shall be established upon terms in conformity with the terms of payment specified in Article 23 for the final 10% payment and shall also include terms in conformity with Articles 30 and 31 in the event of cancellation of this contract pursuant to said articles. In the event that all payments under the two letters of credit have not been completed 10 days prior to the date of their expiration then the periods of such letters of credit shall be extended for such further periods as may be mutually agreed upon. If such letters of credit have not been extended upon their expiration dates the issuing bank shall draw the unpaid balance of each of such letters of credit and shall place the amounts of such balances in a special deposit account to be made available to the Contractor against presentation of the same documents as provided in the letter of credit, a) until such time as the Contractor and the Purchaser shall jointly notify said bank that all payments under the contract have been effected, b) or until such time as the Board of Arbitration by an award rendered pursuant to Article 32 shall determine that cancellation pursuant to Article 29 has become effective, or c) until such time as the Board of Arbitration by an award rendered pursuant to Article 32 shall determine that all payments to the Contractor pursuant to Article 31 have been completed in case cancellation takes place pursuant to such Article 31, on the occurrence of either of which events any balance still remaining in said special deposit account shall revert to the Purchaser.

X - WARRANTIES.

ART. 28. a) The Contractor declares and warrants that:

1) The material, the workmanship, the manufacture, construction and assembly of the equipment shall be first class in every detail.

2) The equipment, once constructed and assembled at the plant of the Purchaser, shall constitute a complete and efficient operating unit with an operating capacity on a commercial scale at the rate and capacity established in Specification of Nov. 6, 1942 if it is assembled under the supervision of the Engineer of the Contractor as provided for in Article 37.

3) The equipment to be supplied in accordance with this contract including all extras by virtue of Article 14 will comply in every regard with the Specification of Nov. 6, 1942 and with the specifications for any of such extras and with the representations and warranties herein established.

b) The Contractor, for his own account, shall repair promptly or shall replace FAS vessel New York, upon the written request of the Purchaser, any material or part comprising such equipment:

1) which does not comply with the specifications, representations or guarantees herein established, or

2) which may be of incorrect or defective design, or

3) which, in normal proper use or operation and proper maintenance, may show defects of workmanship or material, appearing within a period of twelve months as from the date on which the equipment was placed in commercial operation for the first time at the plant of the

Purchaser, but in no case shall such period of time exceed eighteen months as from the date on which the equipment was ready for shipment from the factory, it being understood that such period of twelve months and such period of eighteen months shall be extended for a period of time equivalent to the time during which the equipment is out of operation after the installation of same, as a result of the defects of the material or workmanship used in its manufacture unless this period of eighteen months has expired before its operation.

XI - CANCELLATIONS

ART. 29. In case the Contractor has not completed the manufacture of the equipment eighteen (18) months from the date that this contract was signed by the last contracting party, plus the extension for the dormant period specified in Article 1, and providing that such failure to complete is due to causes other than force majeure as defined herein or acts of the Purchaser its representatives or Consulting Engineer, the Purchaser may at any time thereafter cancel this contract by written notice to the Contractor, except for failure to complete such parts of the equipment which can be completed at a later date without delaying the installation and operation of the equipment. In case of such cancellation the Contractor agrees to return to the Purchaser the amounts paid hereunder, except to the extent that the Purchaser retains delivered equipment. As to equipment delivered to the Purchaser, the Purchaser shall have the right (a) to retain the same in which case any unpaid amounts applying thereto shall become due and payable or (b) to return such delivered equipment to the Contractor in the same condition in which it was delivered to the Purchaser, upon which return the Purchaser shall be entitled to the return of any moneys paid by it to the Contractor as to such returned equipment. The foregoing represents the entire liabilities of the parties hereto in case of cancellation under this Article 29.

ART. 30. In case completion of the equipment does not occur within eighteen (18) months from the date that this contract was signed by the last signing party (plus the extension for the dormant period specified in Article 1) and providing such failure to complete is due to force majeure as herein specified then there shall be an additional extension for the period of the existence of such force majeure under the following conditions:

(a) If such completion date is extended for a period of six (6) months beyond said eighteen (18) months (plus the extension for the dormant period) by reasons of acts of the public enemy of the United States of America, or by acts of the Government of the United States of America or any agency thereof, then the Purchaser reserves the right at any time thereafter to cancel this contract by written notice to the Contractor on the following basis:

(1) The Purchaser shall pay to the Contractor the full purchase price for such of the equipment as has been delivered in accordance with the terms hereof and also for such of the equipment as has been completed in accordance with the terms hereof but not yet delivered.

(2) The Purchaser shall pay to the Contractor all expenses incurred by the Contractor in the partial performance of the Contract to which such cancellation applies (except expenses in connection with completed equipment) including all labor and material costs, liquidation of commitments, and all other items of expense with respect to such partially completed equipment in accordance with the standard accounting practice of the Contractor.

(3) In case of cancellation under this Article 30 and upon payment of the amount specified in (1) and (2) of this Article the

partially completed equipment shall become the property of the Purchaser, but at the option of the Purchaser expressed in its notice of cancellation the Contractor shall retain title to such partially completed equipment and will determine in accordance with its standard accounting practice the salvage value of such partially completed equipment and will deduct such salvage value from the amounts payable by Purchaser pursuant to (1) and (2) of this Article 30.

(b) If the equipment is not completed at the expiration of said eighteen (18) months period (plus the extension for the dormant period specified in Article 1) for reasons of force majeure as herein defined other than by acts of the public enemy of the United States of America, or by acts of the Government of the United States of America, or any agency thereof, then unless otherwise agreed the Contractor shall, to the extent that its own facilities for the manufacture of such partially completed equipment are or will not be available within a reasonable period of time, and to the extent that adequate and competent manufacturing facilities of other manufacturers in the United States, East of Chicago, Illinois or Milwaukee, Wisconsin, are available for such purpose, sub-contract with such other manufacturers for the manufacture of all or a part of such unfinished equipment to the extent that arrangements can be made with such other manufacturers, and it is agreed that such sub-contracting shall not increase the price to the Purchaser of the equipment included herein.

ART. 31. The Purchaser reserves the right to cancel this contract by written notice to the Contractor at any time in whole or in part by paying to the Contractor the following amounts:

(a) The full purchase price of all such parts of the equipment as are completely manufactured, either delivered or undelivered.

(b) All expenses incurred by the Contractor in the partial performance of this contract to which such cancellation applies (except costs in connection with completed equipments) including all labor and material costs, liquidation of commitments, and all other such items of expense as to such partially completed equipment as may be determined in accordance with the Contractor's standard accounting practices, and in the event that the parties hereto are unable to agree upon the amount of such expenses, the same shall be determined by Arbitration pursuant to provisions of Article 32 hereof.

(c) 10% of an amount arrived at by subtracting from the total contract price of the equipment included in this contract, the amount paid pursuant to paragraph (a) of this Article 31.

(d) In case of cancellation under this Article 31 and upon payment of the amounts specified in (a), (b) and (c) the partially completed equipment as well as the fully completed equipment shall become the property of the Purchaser, but at the option of the Purchaser expressed in its notice of cancellation the contractor shall retain title to such partially completed equipment and will determine the salvage value of such partially completed equipment in accordance with the Contractor's standard accounting practice and shall deduct from the amounts, payable by the Purchaser pursuant to (a), (b) and (c), the salvage value of such partially completed equipment as so determined.

XII.- ARBITRATION

ART. 32 a) Any controversy, claim, dispute or difference arising out of or relating to this Contract shall be settled by Arbitration by three (3) Arbitrators, one (1) appointed by each party and a third by mutual agreement by the two thus appointed. If either party shall fail or neglect, within a period of fifteen (15) days after written notice by the other, to appoint an arbitrator, then and in that event the arbitrator for such party shall be appointed by the Chief Justice of the Supreme Court of the United States, but if he fails to appoint an arbitrator within ten (10) days then the arbitrator shall be appointed by such officer of the Government of the United States as may be mutually agreed upon, within ten (10) days or if after being appointed he fails within ten (10) days to appoint the arbitrator then the President of the American Society of Mechanical Engineers or the President of the American Institute of Electrical Engineering, provided the appointing officer is not connected with the interested companies, shall appoint the arbitrator. If the two arbitrators appointed by the parties fail or neglect, within a period of fifteen (15) days after the appointment of the last arbitrator so appointed, to agree upon the third arbitrator, then such third arbitrator shall be appointed as above provided for the appointment of a second arbitrator, where one of the parties fails to appoint its arbitrator. The Arbitration shall be held in the City of New York, except as provided in paragraph b) of this Article. The decision of the Arbitrators shall be by majority and shall be binding upon both parties and the expense of the arbitration shall be divided as the Arbitrators may determine.

b) In case any controversy, claim, dispute or difference should arise as the result of the operation of the equipment in Uruguay, the arbitration shall take place as specified in a) except that in case the two arbitrators fail or neglect to appoint the third arbitrator within the time specified in a), such third arbitrator shall be appointed by the Supreme Court of Justice in Uruguay.

XIII - PATENTS

ART. 33. In case any lawsuit, claim, complaint, action or litigation is instituted on the ground that the equipment or part of the equipment supplied by the Contractor constitutes an infringement of a U.S.A. patent, the Contractor shall defend for his own account all and any such demands, complaints, actions or litigations and shall pay all damages and costs assessed by the Courts against the Purchaser. If the Purchaser should be prevented at any time from using any of the said equipment or parts thereof due to any infringement of any patent of the U.S.A., the Contractor shall promptly and for its own account, secure for the Purchaser the right to continue using such equipment or parts thereof or replace same with other equipment not infringing upon any patent, which shall apply as nearly as possible to the requirements of this contract realizing that a substitution has to be made. The Contractor may at any time for its own account replace the equipment or parts thereof concerning which any claim of infringement of any U.S.A. patent has been submitted, by equipment or parts not infringing upon patents and complying with the requirements of this contract, or assume and conduct the defense of any lawsuit, action or litigation of this kind for its own account, provided that during the defense of such lawsuit, action or litigation the operation of the plant of the purchaser is not unduly interrupted by reason of a permanent restricting order or injunction or by any provisional order or injunction which is not set aside within a reasonable period of time. The Purchaser shall have the right to retain for his own account a lawyer selected by him in order to assist in the defense of such claim, action, proceeding or litigation.

The Purchaser shall promptly advise the Contractor of such complaint, action, lawsuit or proceedings, in writing, authorizing it and giving it all available information and assistance (for the account of the Contractor) for the proper defense thereof.

The Contractor shall in no case be responsible for any agreement or settlement entered into without its written consent. The Purchaser shall assume full responsibility for the infringement of any Uruguayan patent by the equipment or the use thereof in Uruguay, the Contractor being responsible only up to the limit herein indicated for the infringement of U.S.A. patents.

XIV - TRANSFER

ART. 34. The Contractor may not transfer this Contract or the corresponding order, in whole or in part without the written consent of the Purchaser. This provision shall not prevent the Contractor from sub-contracting. Even though this transfer is agreed to by the Purchaser, the Contractor shall continue to be responsible for the performance of this contract.

XV - MARITIME SHIPMENT

ART. 35. The Purchaser or its appointed representative shall engage shipping space on available vessels with destination to Uruguay which are to sail on the nearest date after the respective dates on which the shipping units are ready for shipment. The Contractor shall fully cooperate with the Maritime agent appointed by the Purchaser or its representative, trying to facilitate and assure the shipment in sufficient time in accordance with the conditions which may prevail from time to time so that the equipment may arrive at the port of shipment reasonably ahead of the date of the schedule sailing indicated by the Maritime agent of the Purchaser.

The Contractor shall supply to the Maritime agent of the Purchaser all the data necessary as to weight and dimensions of the equipment prepared for shipment, and shall prepare and supply all the commercial invoices cooperating with the Purchaser for the obtaining of all the other documents which may at times be necessary so that the maritime agent of the Purchaser may effect the shipment. The markings and the shipment shall be made in accordance with the instructions to be supplied by the Purchaser or its appointed representative. The equipment shall be packed, boxed, or crated for underdeck ocean shipment in accordance with the standard practice of the manufacturer.

XVI - TAXES

ART. 36. Any sales, excise or manufacture tax (other than taxes of income or profits) or any increase in any such tax imposed by the Government of the United States or any other State, municipality or any subdivision thereof, subsequent to the signature of this contract will be for the Purchaser's account, to the extent that the law of the Contractor's country permits. The Purchaser shall be liable for the payment of all taxes imposed in connection with this equipment by Uruguay or any State, municipality or sub-division thereof.

XVII - ERECTION

ART. 37. a) The Contractor shall supervise through a duly qualified erection Engineer, the erecting, installation and placing in operation of the equipment in the Hydroelectric Works of the Rio Negro in Uruguay. The Purchaser shall pay for the services, traveling expenses and other expenses from the time the Erection Engineer leaves the Contractor's factory until his return to same after completion of the work - these amounts not to exceed those specified in the following sub-paragraphs:

b) The Purchaser shall pay for the services of the said

Erection Engineer at the rate of $25.00 U.S. currency per day, from the time he leaves the factory of the Contractor until his return to same. It must be understood that for services exceeding 48 hours per week the rate shall be time and a half of the normal rate and for Uruguayan holidays and Sundays the rate shall be twice the regular rates. The rates for the payment of the service of said Engineer during the time of travel shall in no case exceed U.S. $25.00. The Purchaser shall pay the following expenses incurred in connection with the services of the Erection Engineer:

1) First-Class travel and reasonable expenses of maintenance from the time the Erection Engineer leaves the factory of the Contractor where he works until his arrival at Rincon del Bonete, Uruguay, and also first-class travel and reasonable expenses for maintenance of the Erection Engineer from the time he leaves Rincon del Bonete, until his arrival at the said Contractor's factory and while he travels in the performance of his duties for the Purchaser. The trips from the United States to Uruguay and return may be made either by vessel or by airplane, at the option of the Contractor.

2) The Purchaser shall pay for or provide suitable lodging at the place of work and shall also provide board as long as the Engineer is at such place or shall pay for such board at a rate not exceeding 6 Uruguayan Pesos per day.

3) Any taxes or charges which are imposed in accordance with the laws and regulations of Uruguay due to the services of such Erection Engineer, by virtue of these presents.

4) Any expenses of the said Erection Engineer other than those specified shall be for the account of the Contractor.

c) The hours of work required of the Erection Engineer shall agree in general with the standard working hours for employees of the same class as that of the said Engineer doing similar work in Uruguay. As it is not possible for a single supervising Engineer to observe in detail all the operations carried out by the working men, the Contractor shall not be responsible for acts of, or damages to working men, for damages to property or for injuries to third parties, or for extra expenses incurred in the erection of, for damages due to unavoidable causes or other causes of force majeure.

d) It must be understood that the Erection Engineer's time sheets shall be submitted to the Purchaser for approval.

e) The invoices for services and expenses of the Erection Engineer shall be submitted monthly and shall be paid within a period of 30 days from the date of the invoices. The payment shall be made in U.S. Dollars at the Office of the Contractor in York, Pa.

f) The Purchaser shall advise the Contractor when the Erection Engineer shall be required and he shall also advise the Contractor and the Erection Engineer when the services of the latter are no longer required. During the period of time during which the said Engineer is in Rincon del Bonete in the performance of his duties, he shall cooperate with the Engineers of the Purchaser and with the Engineers employed by other suppliers, who may be present at the place of the work at the same time as he.

XVIII - SUBSTITUTION OF MATERIAL

ART. 38. Although it is the intention of the Contractor to supply the equipment in accordance with the specifications referred to in Chapter I, the Contractor reserves the right, subject to the approval of the Consulting Engineer, to change the equipment or the material in those cases in which, as a result of the War Production Program of the U.S.A., it is impossible to obtain the equipment or the specified material. It is understood that such substitution shall not change the performance characteristics and the mechanical strength of the equipment or its overall dimensions without consent of the Purchaser. There shall not be any increase in cost because of such substitution unless agreed to by the Purchaser, but there shall be a reduction if the use of the material substituted should cause a reduction in the cost.

XIX - EXPORT LICENSE AND PRIORITY

ART. 39. The Purchaser will make all necessary arrangements for the obtaining of Export and other licensing permits for the Export of the equipment embraced by this order and shall also have the responsibility (but with no obligation in case of failure) for securing satisfactory priority and other certificates and permissions, allocations and authorizations from the United States Government so as to enable the Contractor to manufacture the equipment included in this contract and to obtain the materials for such manufacture, it being of course understood that the Contractor will cooperate when requested by the Purchaser in assisting the Purchaser to obtain the various licenses, permits, permissions, certificates, allocations and authorizations, covered by this Article 39.

XX - STORAGE

ART. 40. In case shipment from the factory or delivery FAS vessel New York cannot for any cause beyond the Contractor's control be made after the equipment is completed and ready for shipment or delivery, the Contractor upon fifteen (15) days written notice to the Consulting Engineer shall have the right to place the equipment in storage at its factory or elsewhere for the Purchaser's account and risk. The Purchaser shall have the right to designate the place of storage other than Contractor's factory for such equipment, provided (a) it is located in Continental United States East of the Mississippi, and (b) that there are suitable railroad facilities to the place of storage, and in such case the Contractor will, if requested by the Purchaser, advise as to the suitability of such storage. Any charges for such storage, including transportation to the site of storage, in and out charges, and insurance, if placed, shall be paid by the Purchaser upon submission of invoice thereof, it being provided, however, that the Contractor shall pay such storage charges up to an amount equal to the cost of delivery FAS vessel New York. Storage at Contractor's factory after the first fifteen (15) days will be at the rate of 5¢ per day per cubic foot. Such delivery into storage shall complete the Contractor's delivery obligations hereunder, and shall be deemed the full equivalent of delivery FAS vessel New York for payment and all other purposes under this contract. Any expenses for movement of the equipment thereafter shall be for the Purchaser's account.

XXI - CONSEQUENTIAL DAMAGES

ART. 41. In no event will the Contractor be liable for consequential damages as a result of warranties, patent infringement or otherwise.

XXII - COMMUNICATIONS

ART. 42. Any communications, drawings or informations which must be sent to the Purchaser or his representative by virtue of these presents shall be sent by mail, telegraph or cable, addressed as follows:.

Comision Tecnica y Financiera de las
Obras del Rio Negro (RIONE)
c/o Harza Engineering Company
205 West Wacker Drive
Chicago, Illinois

Any communications, drawings or informations to be sent to the Consulting Engineer by virtue of these presents shall be sent to him by mail, telegraph or cable, addressed as follows:

Harza Engineering Company,
205 West Wacker Drive
Chicago, Illinois

Any notifications, drawings or information to be sent to the Contractor by virtue of these presents shall be sent to it by mail, telegraph or cable, addressed as follows:

S. MORGAN SMITH COMPANY,
York, Pennsylvania.

IN WITNESS WHEREOF each of the parties has had this instrument signed by its duly authorized representatives.

Place and Date of Signature:

Washington, D.C.
13 Jan., 1943

Comision Tecnica y Financiera de las
Obras Hidroelectricas del Rio Negro

By:
(Under Power of Attorney)

By:
(Under Power of Attorney)

Place and Date of Signature:

York, Pa., U.S.A.
January 9, 1943

S. Morgan Smith Company

By: B. E. Smith
President

Attested By: Duncan D. McArthur
Secretary

EXTRACT FROM THE MINUTES OF THE MEETING OF THE BOARD OF DIRECTORS OF THE S. MORGAN SMITH COMPANY OF YORK, PA.

HELD ON DECEMBER 10th, 1934.

"RESOLVED that all contracts must be agreed to by two or more officers and that, in the absence of the President and/or the Vice-President, the Secretary and/or the Assistant Secretary and/or the Treasurer are hereby authorized to sign all contracts, Proposals, Bills of Sale and/or Bonds which the Company may make in the conduct of its business, and which may require signing, and affix the Corporate Seal when necessary."

I hereby certify that the above is a true and exact copy of the resolution appearing on the Minute Books of the S. Morgan Smith Company covering the Meeting of the Board of Directors held on December 10th, 1934.

W H Musser
Assistant Secretary

SPECIFICATIONS
for
COMPLETION OF TURBINE EQUIPMENT, AND GOVERNOR
for
ONE ADJUSTABLE BLADE TURBINE

* * * * *

RIO NEGRO PROJECT

* * * * *

COMISION TECNICA Y FINANCIERA DE LAS
OBRAS HYDROELECTRICAS DEL RIO NEGRO
MONTEVIDEO, URUGUAY.

Harza Engineering Co.
205 W. Wacker Drive,
Chicago, Illinois,
U.S.A.

September 26, 1942

ENGINEERING SPECIFICATIONS

TURBINE

1. WORK INCLUDED. The work consists of furnishing and delivering F.A.S. vessel, New York, the rotating parts, gates, gate-operating mechanism, throat ring, bottom plate, headcover, bearing, etc., for one complete adjustable-blade turbine, excepting only the embedded parts hereinafter listed, to complete the installation of one turbine for the Rio Negro Project (Obras Hydroelectricas del Rio Negro), Uruguay, with governor and accessories; and the services of supervising erectors, all in accordance with detailed requirements of these specifications.

Embedded Parts Now Installed

(a) Draft tube, liner and flange.

(b) Speed ring.

(c) Supporting ring between speed ring and draft-tube liner.

(d) Steel plate spiral casing and penstock.

(e) Pit liner.

(f) Anchor rods, supporting jacks and accessories, as required for and incident to the proper installation of the foregoing part.

Drawings showing arrangement and details of the turbine parts already installed and embedded in the concrete, will be provided to the Contractor by the Purchaser. The Contractor shall so arrange and design the work to be furnished by him that it shall fit the installed work and shall be readily attached thereto as necessary or required, subject to correctness of information furnished to the Contractor as to exact details and dimensions of embedded parts.

2. CONTRACT DRAWINGS, ETC. The following drawings form a part of these specifications:

P-5837-B-1 - Wheel section showing parts to be furnished by the turbine manufacturer.

P-5837-D-1 - Lifting arrangement and support frame.

P-5837-C-4 - Proposed method for welding runner blades.

In case of discrepancy between these drawings and the following specifications, the latter shall take precedence.

The Contractor shall submit to the Consulting Engineer for approval at least the drawings hereinafter listed, in accordance with Article II-(c) of the contract:

Drawings

General drawing - Elevation
" " - Plan
Wheel drawing - Sectional elevation
" " - Plan
Runner hub assembly - Sectional elevation
" " " - Sectional plan
Oil head and support
Throat ring detail
Shaft detail
Cover plate details
Bearing assembly
Blade servo-motor assembly
Gate " "
Gate mechanism assembly
Air valve assembly
Governor arrangement and piping
Pressure tank detail
Stairways and walkways in pit
Piping arrangement
Wiring diagrams
Provisions for lubricating parts

The drawings shall show the materials, dimensions, finish, fits, clearances, tolerances and such other information as necessary to demonstrate compliance with the requirements of the specifications.

The unit shall conform to the following estimated data:

(a)	Runaway speed at 32.0 m. (105 ft.) head, with full gate and blade opening, or at any governor-controlled gate and blade relationship normally used in operation -	310 r.p.m.
(b)	Runaway speed at 32.0 m. head, with no load, at full gate opening and with runner blades at angle giving the highest runaway speed - - - - - - - - - - - - - - -	365 r.p.m.
(c)	Weight of rotating parts - - - - - - - - - - -	353,000 lbs.
(d)	Weight of rotating parts and unbalanced hydraulic thrust at 32.0 m. (105 ft.) head -	1,433,000 lbs.
(e)	Net weight, heaviest piece - - - - - - -	53,000 lbs.
(f)	Weight of complete assembly of turbine shaft, runner bearing and headcover to be lifted by powerhouse crane - - - - - -	368,000 lbs.
(g)	Natural frequency of the turbine, in cycles per second - - - - - - - - - - - -	12.5
(h)	Total weight of turbine and spare parts -	860,000 lbs.
(i)	Weight of governor - - - - - - - - - - -	125,000 lbs.
(j)	Governor capacity - - - - - - - - - - -	338,000 ft. lbs.

(k) Calculated Speed Changes

When operating under the conditions stated below, the speed regulation for sudden load changes is calculated to be as follows:

Normal speed of turbine - - - - - - - - - - 125 R.P.M.
Net effective head - (16.7 m) - - - - - - 54.8 feet.
Length of pipe line - (55 m.) - - - - - - 180 feet.
Average velocity in pipe line for
30,000 H.P. load on one turbine - - - - 13.93 ft.per sec.
Full gate stroke - load on - 5 seconds.
load off - 5 seconds.
WR square in generator rotor - - - - - 36,000,000 ft. sq.lbs.

Sudden Load Changes	Speed Variation	
	Load Off	Load On
30,000 H.P.	28.6%	- %
22,500 "	17.3	-
15,000 "	8.7	12.7
7,500 "	2.9	4.0

The calculated maximum pressure rise for 30,000 H.P. load rejected under 54.8 ft. head in 5 seconds time is 46.0 %.

Normal speed of turbine - - - - - - - - - - 125 R.P.M.
Net effective head - (21.1 m.) - - - - - 69.2 feet
Length of pipe line - (55 m.) - - - - - 180 feet.
Average velocity in pipe line for
44,400 H.P. load on one turbine - - - - 16.27 ft.per sec.
Full gate stroke - load on - 5 seconds.
load off - 5 seconds.
WR square in generator rotor - - - - - - - 36,000,000 ft.sq.lbs.

Sudden Load Changes	Speed Variation	
	Load Off	Load On
44,400 H.P.	37.3%	- %
33,300 "	23.5	-
22,200 "	12.1	17.9
11,100 "	4.1	5.5

The calculated maximum pressure rise for 44,400 H.P. load rejected under 69.2 ft. head in 5 seconds time is 46.0%.

3. MATERIALS. All materials used in the construction of the apparatus shall be selected as the best available for the purpose for which used, considering strength, ductility, durability, and best engineering practice, and shall conform at least to the specifications in Table I - Material Specifications.

Liberal factors of safety shall be used throughout the design and especially in the design of all parts subject to alternating stresses or shock, as hereinafter specified. For the rotating parts of the turbine, the maximum unit stresses due to runaway speed shall not exceed two-thirds of the yield point. The maximum unit stresses for materials used for the head cover and other parts subject to hydrostatic pressure or alternating stress shall not exceed the values in the following table, at the maximum loads occasioned by the most severe operating conditions, with the exception that a stress of two-thirds of the yield point will be allowed in the wicket gates, wicket-gate stems and wicket-gate stem levers at the breaking point of the breaking elements.

	Maximum unit stress in pounds per square inch	
	Stress in tension	Stress in compression
Cast Iron	2,000	10,000
Cast Steel	10,000	10,000
Alloy Cast Steel	20 percent of the ultimate strength or 33 percent of the yield point	20 percent of the ultimate strength or 33 percent of the yield point
Plate Steel for Principal Parts	12,000	12,000

TABLE I - MATERIAL SPECIFICATIONS

NAME OF PART - OR MATERIAL	A. S. T. M. SPECIFICATION	MINIMUM REQUIREMENTS			
		TENS.STR. Lbs./sq.in.	YIELD POINT Lbs./sq.in.	% ELONG. in 2"	% REDUCTION in Area
Main Shaft	A-235-40T Class E-Modified	75,000	37,500	24	40
Piston Rods & Gate) Servo-Motor Connecting Rods)	A-235-40T Class G	82,500	48,000	19	36
Other Steel Forgings	A-235-40T Class E	Physical Properties Variable with Dia. as per Spec.			
Cross Head & Rocker Arms	- - - -	90,000	60,000	18	30
Wicket Gates (Steel Castings)		65,000	35,000	20	30
Other Steel Castings	A-27-42, Grade B2	65,000	35,000	20	30
All Iron Castings	A-48-41, Class 25	25,000			
Plate Steel	A-89-39, Grade B, Firebox quality	50,000	0.5 tensile strength	$\frac{1,650,000}{\text{tens.str.}}$	
Bronze Bushings) Except for Blade Trunnions)	B-144-41T, Class 3A	25,000	12,000	8	
Other Bronze Castings	B-30-40T, Class 4A	Chemical Analysis Only			
Corrosion-Resisting Steel		Chromium - %	Nickel - %	Carbon - %	
On Runner Blades	A-167-41, Grade 3	18	8	0.08 Max.	
Sleeves for Shaft, Blade Trunnions & Gate Stems	A-176-41, Grade 2	12-14	.60 Max.	0.12 Max.	
Bolts	A-176-41, Grade 2	12-14	.60 Max.	0.12 Max.	

For other materials used in the construction of the apparatus, the maximum unit stress due to maximum head and the most severe normal operating conditions shall not exceed one-third of the yield point nor one-fifth of the ultimate strength of the material.

The Contractor shall, upon request of the Engineer, furnish complete information as to the maximum unit stresses used in the design or else all information necessary to check the design.

All welding shall be in accordance with the American Society of Mechanical Engineers Boiler Construction Code for Unfired Pressure Vessels, Section VIII. All steel castings and the welded steel plate work which will be subject to hydrostatic pressure or alternating stresses shall be stress-relieved by annealing, as outlined in the aforementioned code.

The materials used in the manufacture of the apparatus shall be tested in accordance with the details thereof in the applicable specifications. The Contractor shall furnish the Consulting Engineer with certified copies of reports of tests of the materials, in such form as to provide means of determining compliance with the specifications.

The cost of making all of the above required tests shall be borne by the Contractor. The Consulting Engineer shall have the right to select additional test specimens of any of the materials to be used and to make tests of the same, at the expense of the Purchaser.

The Contractor shall notify the Inspector in time to be present at the steel casting foundry:

(a) When castings are cleaned ready for surface inspection and before any repairs are made.

(b) After repairs are completed and before annealing.

(c) After annealing and before shipment to the machine shop.

No repairs shall be made to castings without the knowledge and approval of the Inspector. Cracks or other defects disclosed when the castings are cleaned or during machining operations shall be chipped off down to sound, clean metal before any repairs are made. Castings requiring welding repairs at any stage of manufacture after the first annealing shall be re-annealed unless otherwise permitted by the Inspector.

Purchase Orders. Two copies of all purchase orders, showing firm names and addresses and list of material, shall be furnished the Inspector as soon as issued. Orders shall be so worded or marked that each item may be identified in the plans for the work.

4. WORKMANSHIP. All work shall be done and completed in a thorough, workmanlike manner and shall follow the best modern practice in the manufacture of high-grade machinery, notwithstanding any omissions from these specifications or drawings. All work shall be done by mechanics skilled in their various trades. All parts shall be made accurately to standard gauge when possible so as to facilitate repair and replacement.

5. COOPERATION WITH OTHER CONTRACTORS. The turbine contractor and his governor sub-contractor shall exchange between themselves and the generator contractor, all necessary drawings, dimensions, templates, gauges, and other information required to insure the complete and proper design and manufacture of all connecting or related parts of the turbine, governor and generator. Two copies of all drawings and all correspondence relating to drawings and specifications interchanged between con-

tractors shall be sent to the Consulting Engineer.

The Contractor shall be responsible for errors in the information that he supplies to the governor subcontractor and/or the generator contractor. Any adjustments due to such errors shall be made without involving extra cost to the Purchaser. Adjustments required at the site to secure accurate fit and proper clearances with the parts actually in place will be the responsibility of the Purchaser, if such work is necessary through no fault of the Contractor.

6. TYPE AND DESCRIPTION OF TURBINE. The turbine shall be of the vertical shaft, adjustable-blade propeller type, to be installed in the already-placed embedded turbine parts. The turbine shall be so designed and constructed that all removable parts, including runner, shaft, guide bearings, guide bearing support, crown and bottom plates, gate operating mechanism, and the wicket gates can be removed from above. The turbine contractor shall cooperate with the generator contractor to the end that the largest turbine part required to be passed through the generator stator may be accommodated by the opening through the generator stator.

The turbine shall be designed for a capacity at full gate of not less than 40,000 horsepower at a net effective head of 21.1 m (69.2 ft.), and not less than 30,000 horsepower at a net effective head of 16.7 m (54.8 ft.). It shall operate at any gate and at all available heads, corresponding to head and tailwater conditions as hereinafter listed, within the cavitation limits to be established by the contractor after making model tests.

The contractor shall furnish, in addition to the load limit stop on the governor, an adjustable mechanical stop on the piston stroke of the gate servo-motor or other approved device.

All parts of turbine shall be designed and constructed to withstand, without injury, the stress produced by the maximum runaway speed of the unit when operating at 32.0 m (105.0 ft.) net head, with no load on the generator.

Head Variations. The normal pool level for the initial installation will be at elevation 80.0 m (262.0 ft.), to be increased subsequently to elevation 84.0 m (275.6 ft.) for the ultimate installation.

The proposed operating conditions will be as follows:

	Initial Installation	Ultimate Installation
Normal pool elevation	80.0 m.(262.0 ft.)	84.0 m.(275.6 ft.)
Maximum pool elevation	82.8 m.(271.5 ft.)	85.4 m.(280.0 ft.)
Minimum pool elevation	71.5 m.(234.5 ft.)	71.5 m.(234.5 ft.)
Tailwater elevation, - no discharge	50.0 m.(164.0 ft.)	50.0 m.(164.0 ft.)
Tailwater elevation, - 160 m^3/sec. (5,650 cfs) discharge	52.2 m.(171.2 ft.)	52.2 m.(171.2 ft.)
Tailwater elevation, - 640 m^3/sec. (22,600 cfs) discharge	54.4 m.(178.5 ft.)	54.4 m.(178.5 ft.)

It is proposed to discharge over the spillway at any time the normal elevation of the pool is exceeded, thus raising the tailwater, as indicated on the tailwater rating curve attached to these specifications. For all headwater elevations above normal pool level, the turbine will, therefore, operate with materially raised tailwater and reduced head. Previous studies indicate that spillway discharges of 3,000 m^3/sec. to

4,500 m^3/sec. (105,000 to 160,000 cfs) may seldom be expected; whereas discharges of 2,000 m^3/sec. to 2,500 m^3/sec. (70,000 to 90,000 cfs) may be very frequent. The variation in tailwater at different discharges is shown on the accompanying curve sheet No. R-SK-1.

Speed and Rotation. The normal speed of the turbine shall be 125 r.p.m. Rotation shall be in counterclockwise direction when viewed from top down.

The turbine shall be so designed that the maximum runaway speed, with no load on the generator, will not exceed the runaway speed determined from the model tests but not more than 365 r.p.m. at 32.0 m (105.0 ft.) net head, with full-open turbine gates and partially closed blade opening, or any other gate and blade relationship giving highest runaway speed. If the model tests indicate higher runaway speed than herein specified, then the Contractor shall provide, at additional cost, limit stops or other means to limit the runaway speed so that the specified speed will not be exceeded.

7. TURBINE MODEL TESTS. The Contractor shall conduct model laboratory tests to indicate the efficiency and power, and the power output limits, of the prototype turbine.

The Contractor shall construct a test model of the turbine exactly homologous with the turbine to be furnished. The blades of the model runner shall be manually adjustable to angles conforming to the prototype. The model tests shall be made in a scroll case, speed ring and draft tube setting homologous to the prototype.

The cavitation limits of the full size turbine shall be carefully determined by the model tests, under the head and tailwater conditions that will be encountered in normal operation.

The Engineer (and the Purchaser's representative) shall observe and be satisfied as to the results of any such tests. When the Contractor is satisfied as to the results of the model tests, he shall notify the Engineer that the observation tests are ready to be run. The Engineer or his representative will promptly visit the laboratory and witness such tests as he may desire to have repeated.

All above tests, to the extent of two models and one modification of one of same, that are made shall be made at the Contractor's expense, except expenses of the Engineer and the Purchaser's representative which shall be paid by the Purchaser. The Purchaser may arrange for additional tests which he may wish to have run, at the rate of $100 per 8-hour day for the use of Contractor's laboratory. Additional design work and material required for such added tests will be paid for at cost, including overhead, plus 15% for handling charge. Should over-time work of laboratory employees be required for such added tests, the excess cost plus 15% handling charge shall be borne by the Purchaser.

8. EFFICIENCY AND OUTPUT. The turbine shall be designed to afford the best efficiency over a wide range of gate openings for heads between 21.1 and 27.0 meters (69.0 and 88.5 feet), and the specified outputs, as follows:

Maximum output - - - - - - - - - - - - - - - - - - 45,000 hp

Full gate capacity at 21.1 m. (69.2 ft.)
net head - 40,000 hp
(with headwater elev. 76.0 m. (249.5 ft.))
(and tailwater elev. 54.5 m. (179.0 ft.))

Full gate capacity at 16.7 m. (54.8 ft.)
net head - 30,000 hp
(with headwater elev. 71.5 m. (234.5 ft.))
(and tailwater elev. 54.4 m. (178.5 ft.))

At the conclusion of the model tests guaranteed capacities shall be set based on the model results. The horsepower is to be stepped up according to the 3/2 power of the heads and the squares of the diameters. The guaranteed horsepower of the prototype shall be 15% less than the figure determined from the model results stepped up as above. The horsepower guarantee shall also be limited by the cavitation results of the model. The cavitation limits in discharge as determined by the model shall be stepped up according to the 1/2 power of the head and the square of the diameter. These limits shall be reduced by 30% and the horsepowers shall then be computed by using these discharges at the corresponding heads and with the efficiencies as stepped up from the model by the Moody formula.

In no event shall the unit be guaranteed beyond the stipulated limits of 40,000 H.P. at 69.2 feet head and 30,000 H.P. at 54.8 feet head.

At heads higher than 69.2 feet, the capacity shall be so limited in operation that the relative safety against cavitation, increased head taken into consideration, shall at least equal the safety at 69.2 feet head.

The efficiency of the prototype runner shall be determined from the efficiency of the model, by correcting in accordance with the "Moody formula" as follows:

$$E_2 = 100 - (100 - E_1) \left(\frac{D_1}{D_2}\right)^{1/4}$$

Wherein D_2 = diameter of turbine runner

D_1 = diameter of model runner

E_2 = efficiency of turbine in percent

E_1 = efficiency of model in percent

The correction shall be applied to the point of maximum efficiency for each blade angle tested. The efficiency at any other point, tested at the same blade angle, shall be the model efficiency increased by the same amount as for the point of maximum efficiency for that blade angle.

9. RUNNER. The runner shall be of the so-called "Kaplan", or adjustable-blade propeller type, with blades automatically operated by the governor with each movement of the control gates, through the medium of an oil servo-motor located in the turbine shaft.

The blades shall be of special grade of alloy steel. The shank of each blade shall be securely held in the runner hub and shall be ample in size and strength to withstand the cantilever weight and hydraulic pressure on the blade with sudden closure under maximum head.

The cross-head, links, hub, blades, and all parts shall be adjusted in weight and distribution of weight to provide accurate rotative balance of the complete runner, which shall be balanced as a whole and tested for static balance in the presence of the Engineer or his representative.

The runner blades shall be protected against pitting by welding a strip of 18% chromium and 8% nickel, or equal corrosion-resisting steel, to the periphery of the blades including the tips and trailing edges, and shall also be pre-welded on the underside or back with stainless steel to a depth of 1/4", in accordance with the thickness of strips, location, etc., as shown on accompanying sketch P-5837-C-4.

All surfaces of the runner which will be in contact with water passing through it shall be finished smooth, so that they shall be free of hollows, depressions, cracks or projections that might cause incipient cavitation or pitting.

10. RUNNER HUB. The hub shall be of annealed cast steel. The portion of the hub to which the blades attach shall be spherical in shape to reduce clearances between blade and hub at all blade positions.

An additional bearing shall be provided for each blade near the center of the hub. These bearings and the thrust bearings for the blade shanks shall be lined with bronze bushings of special composition to withstand the high bearing loads. Corrosion-resisting steel bands shall be installed around the runner blade shanks to form the contact surfaces for the packing rings.

The runner hub shall be designed to be full of oil at all times under a pressure greater than maximum operating tailwater, elevation 54.4 m (178.5 ft.). Satisfactory means of replacing oil lost by leakage and of maintaining such pressure, without the necessity of shutting down for either operation, shall be provided.

The shank of each blade shall be so packed into the hub as to be tight against leakage of oil from the hub during rotation of blade-angle under the oil pressure necessary to exclude highest water pressure and conversely, the packing shall be double acting to prevent entrance of water into the hub in event of accidental deficiency of oil pressure in the hub.

The design and construction of packing ring glands around the blade shank must be such that the rings and packing can be replaced without removal of the runner and shaft. The runner after assembly shall be shop tested for any oil leaks with blades in motion if practicable, or at least in two positions, with an oil of governor oil viscosity and under double the pressure which will exist in normal operation.

11. BLADE OPERATING MECHANISMS.

(a) Oil Supply Head and Control Valve. The oil supply head shall be mounted on top of the generator pilot exciter on a suitable support to be furnished by the generator contractor. The oil supply head, together with suitable packing boxes and seamless steel tubes and connections to the blade servo-motor, and the blade control valve, together with all piping and compensating mechanism between the control valve and the oil supply head shall be furnished by the Contractor.

The Contractor shall cooperate with the generator contractor in securing a neat arrangement of the oil supply head, permanent magnet generator, and a minimum amount of exposed piping between the actuator control valve and oil supply head. All openings in the housing shall be screened in accordance with the generator contractor's specifications. A ladder shall be provided for access to the top of the oil head.

The necessary supply piping from the governor pressure tank to the control valve and return piping from the control valve to the governor sump tank shall be furnished with the governor equipment. Provisions shall be made for returning oil which leaks past the packing boxes in the oil supply head and from the blade servo-motor cylinder to the governor sump tank.

The oil head stuffing boxes shall each be equipped with two thermostatic relays, for operating alarm or automatic shut-down devices located in the actuator cabinet.

The blade servo-motor shall be capable, under maximum or most unfavorable head, of moving the turbine blades a full opening stroke in 5 seconds, with an adequate supply of oil at 250 lbs. pressure. The full closing stroke of the blades shall be in 8 to 10 seconds. Provisions shall be made so that the rate of movement of the runner blades can be adjusted to longer intervals, either opening or closing, if the field operation indicates this to be desirable.

Pressure indicator connections shall be provided on the oil supply head for test of servo-motor performance.

The oil pressure pipe lines within the generator shaft shall be connected at the lower end, with the blade operating cylinder and piston respectively in such a manner that the connection may be accessible for disconnecting by first opening the flange joint of the main shaft above the operating cylinder and then lifting the generator shaft a minimum distance to give access.

The turbine contractor shall furnish an adjustable cam for the proper liaison between the gate movement and blade movement for the full range of head, and shall ship it to his governor sub-contractor, for incorporation in the actuator. The cam shall first be designed from the test data of the accepted model runner and subject to modification on the results of field test of the prototype, using index test or complete efficiency test as a basis. The cam shall be so arranged that it can be readily moved from one position to another to accommodate variations in operating heads.

(b) Blade Operating Mechanism. The runner blade connecting rod required within the main turbine shaft for the operation of the runner blades shall be of such composition and of sufficient size and strength to provide an ample factor of safety against failure from fatigue or other causes. The lower end of this connecting rod or extension to it shall be properly guided below the cross-head.

The connecting rod bearing immediately below the servo-motor cylinder shall be provided with a bronze liner, or other means, which can be replaced to maintain oil tightness in the event of excessive wear.

12. TURBINE SHAFT. The shaft shall be of forged open-hearth carbon

or alloy steel, properly heat treated, 31" diameter for a normal speed of 125 R.P.M. It shall extend 18'-8-7/16" above the centerline of the turbine distributor and shall be in three parts; namely, (1) the lower section attached to the runner hub, (2) the intermediate section containing the blade servo-motor cylinder, and (3) the upper section which connects to the generator shaft. Forged flanged half couplings shall be provided at each end of the upper and lower shaft sections.

The design of the turbine shaft shall be such as to permit the lower flange of the generator shaft to be of normal diameter.

The turbine shaft shall be accurately machined and finished throughout. The entire shaft shall be hollow for operation of the blade operating rod to the hub of the turbine and the machining of the bore shall be finished sufficiently smooth to permit visual inspection of the metal in the interior of the shaft. Just above the bearing housing a circumferential line shall be scribed on the shaft, and an adjustable pointer shall be mounted on the bearing housing opposite this line to indicate if any lowering of the shaft occurs, and to permit re-alignment after thrust bearing dismantling. The shaft shall be polished at convenient location below the coupling and above the bearing to facilitate checking alignment.

The turbine shaft shall have a removable and renewable sleeve of bronze or corrosion-resisting steel (13% to 14% chromium) where it passes through the stuffing box, and shall be enlarged and polished where it passes through the guide bearing in the turbine head-cover. A steel plate or cast iron water deflector shall be provided between the main guide bearing and the stuffing box.

All cylindrical bearing portions of the turbine shaft shall show not more than .0015 inch on the indicator, or .00075 inch from straight. Faces of coupling flanges shall show a maximum of .00075 inch on the indicator. The male projection of the turbine shaft shall show a maximum run-out of not more than .001 inch. The surface of the shaft at the turbine main bearing shall show not more than .001 inch on the indicator.

The turbine contractor shall make such arrangements with the generator contractor as may be necessary to provide an accurate fit between the two halves of the coupling. The length of the male connection which shall be on the turbine shaft shall be approximately 1/2 inch. A sliding fit shall be provided between the two halves of the coupling. The generator shaft will have backing-out bolts in the coupling flange, suitable for breaking the joint.

The turbine contractor shall furnish all coupling bolts and nuts for attaching the generator shaft to the turbine shaft and for the turbine shaft sections. The coupling bolts shall be a close machine fit and of dimensions consistent with the remainder of the design. Taper bolts shall not be used. The coupling bolts shall be provided with suitable locking devices to prevent the nuts from turning loose. The Contractor shall provide a bolt press or jack for inserting and removing the coupling bolts. This bolt press or jack shall become and remain the property of the Purchaser.

The generator shaft will be shipped to the turbine contractor, who shall ream the holes in the generator and turbine coupling flanges and fit the coupling bolts. The turbine contractor shall check shaft sections individually, and then assemble the generator shaft and the sections of turbine shaft on trunnions or vertically for alignment check of the entire shaft. The cylindrical bearing surfaces of the assembled turbine and generator shafts shall show not more than .003 inch on the indicator, or .0015 inch from straight. Thrust bearing faces shall show a maximum of .0015 inch on the indicator.

Alignment shall be witnessed and approved in writing by the generator contractor, the turbine contractor, and the Purchaser or his Engineer. Any corrections to the generator and turbine shaft shall be made immediately, the turbine and generator contractors cooperating to effect this so as to minimize any delays and adhere to the shipping schedules. The turbine contractor shall receive, unload, reload (under supervision of the generator manufacturer's representative), and ship the generator shaft at his expense to the point of delivery, and he shall make allowance therefor in his bid.

13. GUIDE BEARING. The main turbine guide bearing shall be of approved height, of babbitt-lined, oil lubricated type, located above the runner, and shall consist of a bearing support and a removable bearing shell. The bearing shall be located as close as possible to the runner, consistent with convenient access to the main packing gland. It shall be so arranged as to permit at least 5/8 inch vertical movement of the runner and shaft for adjusting and dismantling the generator

thrust bearing. The bearing support shall be of cast iron or welded plate steel of heavy construction, supported on the headcover and designed to hold the bearing shell rigidly.

The bearing shall have removable top cover plates to prevent dirt or foreign matter working its way into the bearing. The bearing housing and bearing shell shall be split vertically into two sections to facilitate dismantling.

The bearing shell shall be lined with babbitt similar and at least equal to Tuftex No. 20 alloy, thoroughly peened, accurately bored, and suitably grooved for oil circulation. The bearing shell shall be scraped and polished in the shop to fit properly on the shaft. Suitable lifting eyes and backing-out studs shall be provided to facilitate removing and installing the bearing shell segments and the bearing in a minimum amount of time.

Lubrication of the turbine guide bearing shall be effected by oil circulated through the bearing. The circulation shall be from an oil reservoir in the bottom of the bearing, to the oil pumps, and thence through the bearing, and after passing through the bearing, the oil shall be returned to the oil reservoir. If cooling is necessary, the oil shall be circulated through suitable cooling coils immersed in circulating cold water. Cooling coils shall not be placed in the guide bearing housing. The lubricating oil system shall have sufficient capacity to supply the required amount of oil to the turbine guide bearing, and the oil reservoir shall have sufficient capacity to hold all the oil in the entire bearing system.

Two independent, motor-driven positive displacement, rotary type, oil pumps shall be provided for circulating the lubricating oil. One of the oil pumps shall be driven by a 3 phase, 50-cycle, 380-volt, full voltage starting motor, and the other pump shall be driven by a 250-volt, direct-current motor, power for which will be supplied from the station storage battery. Normally the oil shall be circulated by the alternating-current motor pumping unit, but the direct-current motor shall be arranged to start automatically and supply oil to the bearing on failure of the alternating-current supply. The pump motors shall conform to A.S.A. Standards, shall have enclosed conduit boxes and shall be reasonably protected against moisture. The Contractor shall provide manually operated control switches and overload protection for each pump motor, to be mounted on the instrument panel specified in paragraph 20.

A pressure switch shall be provided in the bearing oil supply line, or a float switch provided in the oil supply reservoir, or both, so as to provide automatic control of the oil pumps as described above and to operate an alarm and indicating light on the switchboard. Provision shall be made to operate an alarm upon failure of the alternating-current pumping unit.

All external wiring beyond the limits of the turbine pit for the motors, alarms, and shut-down features will be supplied by the Purchaser.

Under any condition of normal operation, from speed-no-load to full load, or with the generator running as a motor, no water shall enter the lubricating oil system, and there shall be no appreciable loss of oil by leakage past the lower oil shedder or by overflow from any part of the oil system.

The Contractor shall furnish the sight-flow indicator, oil-level gauge, all piping between the turbine bearing, pumping units and oil reservoir, and temperature relays, indicators, and detectors as specified in paragraph 20. All oil piping shall be brass, with brass valves and fittings.

Stuffing Box. The shaft stuffing box shall be provided with a lantern ring, designed to be easily removable, securely held to prevent rotation with the shaft, and provided with connections for water lubrication. Approved packing rings shall be provided above and below the lantern ring. The stuffing box gland shall be removable, of cast iron or aluminum alloy, split vertically and provided with corrosion-resisting bolts.

A rubber sealing tube device shall be provided around the lower end of the main shaft stuffing box, to minimize the leakage of water while the packing is being replaced.

A suitable water line of copper tubing shall be provided by the Contractor to the stuffing box for its lubrication, one branch of this line to go through the wall of the stuffing box to the lantern ring and the second branch to carry water for circulation around the top of the stuffing box. The Purchaser will bring in clear water supply to one point in the turbine pit and the Contractor shall provide all other piping, fittings, valves, etc. required in the turbine pit.

14. HEAD COVER AND CROWN PLATE. The head cover shall be of welded

steel plates, properly sectionalized for shipment and handling, and shall be made in two units. It shall have a circumferential joint inside of the gate circle of such diameter that the central portion of the head cover, guide bearing, runner and turbine shaft can be completely removed or installed without disturbing the control gate bearings and packing glands. Suitable lifting devices shall be provided at four points of attachment on the head cover for lifting this complete assembly with the crane.

The annular rings of the head cover shall have heavy flanges properly designed so as to prevent undue deflection and shall be bolted in position by means of ample number of corrosion-resisting bolts. The inner cover plate shall be machined as required for receiving the main shaft bearing and stuffing box. The outer cover plate shall be machined for proper mounting, and shall have non-corrosive bushings and adjustable bronze packing glands for upper control of the gate stems.

Removable steel wearing plates, (ASTM A-89-39, Firebox quality, Grade B), shall be provided in the outer cover plate above the wicket gates, the exposed surfaces to form a raised annular ring located to match the points of contact between the head cover and the gates in their closed position. The wearing plates shall be attached with corrosion-resisting screws.

The assembled head cover shall be provided with two openings spaced 180 degrees apart, equipped with 8" diameter automatic air inlet valves to open on sudden rejection of load. Piping shall be provided under the head cover to distribute the air, admitted by the valves, approximately uniformly around the top of the runner. The valves shall act as check valves, or be provided with separate check valves, to prevent the outflow of air or water and shall be adjustable for different gate positions. A hand-operated valve shall also be provided to admit compressed air to depress the water level in the draft tube. The Contractor shall furnish all piping in the turbine pit up to the pit liner, suitably flanged at its terminii at the liner. The piping will be continued from that point by the Purchaser.

If the Contractor considers that air at atmospheric pressure will be inadequate to satisfactorily protect the turbine against sudden rejection of full load, he shall provide and connect to the turbine with piping a storage tank adjacent to each unit for the storage of air at 100 pounds pressure sufficient in amount to relieve any danger to the turbine. Air for this tank will be furnished from the station air compressor system which, with the piping to the tank, will be provided by the Purchaser.

15. BOTTOM PLATE AND DISCHARGE RING. The bottom plate shall be of cast steel and shall be suitably sectionalized if necessary to facilitate shipment and handling. It shall be designed to be bolted to and to be removable from the speed ring and the discharge ring. The contact surfaces between the bottom plate and the speed ring and the discharge ring, shall be machined. The bottom plate shall be machine finished where needed and drilled and bronze bushed as required to receive the lower ends of the gate stems. The bushings shall be lubricated by grease forced through the hollow gate stems. Removable rolled steel wearing

plates, (A.S.T.M. A-89-39, firebox quality, Grade B), attached with corrosion-resisting screws, shall be provided to form an annular ring located to match the points of contact between the bottom plate and the gates in their closed position.

The discharge or throat ring shall be made of welded steel plates, suitably sectionalized for shipment. It shall be stiffened with vertical and horizontal stiffener ribs and flanges, and designed to be bolted to and supported by the present installed equipment with hole locations and sizes properly matched. The interior surface shall be completely machined and the surface below the center of the blades shall be partly spherical in shape.

16. GATES AND OPERATING MECHANISM. The turbine wicket gates and gate stems shall be made of steel castings with the stems cast integrally. At the top and bottom of each gate and on the closing edges there shall be welded plates, strips, or beads of corrosion-resisting steel, "13% chrome", of a thickness not less than 1/4 inch. Each gate shall be accurately machined and finished and all gates shall be interchangeable. Three bronze-bushed, grease-lubricated guide bearings shall be provided for each gate, one located in the bottom plate and the other two located in the crown plate, one below and the other above the stuffing box. Each gate stem shall also be provided with a bronze thrust bearing or collar to carry the weight of the gate. Provision shall be made for adjusting and maintaining the adjustment of individual gates in mid-position between the bottom and crown plates. The gate stems shall be drilled and piped for their entire length for grease lubrication of the lower stem

bearings in the bottom plate. Approved packing shall be used in the stuffing boxes in the crown plate.

All parts having relative motion in contact shall be properly bushed with bronze bushings and gate stems and other mating surfaces in contact with water shall have corrosion-resisting steel sleeves. All surfaces shall be provided with convenient and adequate means for forced grease lubrication.

Operating Mechanism. The gate operating mechanism shall be of ample strength to withstand maximum load that can be imposed on it by the most severe operating conditions. The design and construction shall be such that lost motion and wear will be reduced to a minimum and means shall be provided for adjusting the position of any individual gate independently of the others, in order that each gate will make close contact with adjacent gates in closed position, and all gates shall have equal, insofar as practicable, simultaneous openings. Ample surplus adjustment shall be available to compensate for future wear and distortion.

A suitable breaking element shall be provided between each gate stem and the gate shifting ring which will be strong enough to withstand the maximum operating forces, but will break or yield from forces acting in either the opening or closing direction and protect the rest of the mechanism from injury in case one or more of the gates should become blocked.

Stops shall be provided to limit the angle of movement of the gate stem levers in case of breakage of the above-specified protective device, so that interference of the loose gate with operation of the other gates will be prevented. The design of the operating mechanism shall be such that the failure of the breaking element will not interfere with the operation of the other parts.

The entire operating mechanism and connections for controlling the gates shall be readily accessible for inspection, adjustment and repair. The gate shifting ring shall be of cast steel or welded plate steel and shall be properly guided by renewable bronze guide strips. The shifting ring and gate mechanism shall be so located that they do not need to be disturbed to dismantle and replace the main guide bearing shell and accessories.

Provision shall be made by the turbine contractor for the connection of governor restoring mechanism to the turbine shifting ring.

17. GATE OPERATING CYLINDERS (SERVO-MOTORS).

The turbine shall be provided with two oil-pressure operated, double-action, hydraulic cylinders or servo-motors having a combined capacity sufficient to supply the maximum force necessary to operate the gates under all conditions of head and load with a minimum oil pressure of 250 pounds per square inch. The maximum operating oil pressure shall be 300 pounds per square inch, and the cylinders shall be tested in the shop at 450 pounds pressure. At the oil pressure of 250 pounds per square inch, and with adequate supply of oil, the servo-motors shall be capable, under maximum operating head conditions, of moving the turbine gates through a full opening or a full closing stroke in 5 seconds. Oil under pressure, for operating the servo-motors, shall be controlled by the governor actuator.

The servo-motor cylinders shall be of cast iron with cast steel heads, and shall be accurately bored, and provided with flanges for the connecting oil piping, and with stuffing boxes for preventing leakage of oil along the piston rods. The cylinders shall be mounted on machined surfaces on the turbine pit liner. The pistons of the servo-motors shall be of cast iron and shall each be fitted with not less than three cast-iron piston rings suitably shaped to give close contact and uniform pressure on the cylinder walls and prevent leakage of oil past the pistons. Suitable drain valves and piping shall be furnished to drain each end of each cylinder. Taps shall be provided on each end of each gate servo-motor for use in inserting pressure indicators and to permit bleeding the pressure in case of shut-down.

The servo-motors shall be equipped with adjustable means for retarding the rate of closure from slightly below the speed-no-load position to the fully closed position. Suitable mechanical locking devices shall be provided by which the turbine gates may be held securely in the open and closed position against maximum governor oil pressure in the cylinders. A manually adjustable stop or blocking device shall be provided to limit the gate opening when the head is so high as to develop more than the cavitation limit of capacity. This block shall be readily adjustable for different gate openings to suit different heads. A scale affixed to the mechanism shall show the limit for which the device is set. A scale with pointer to indicate actual gate opening shall be provided on one servo-motor.

18. CAVITATION OR PITTING. The Contractor shall guarantee the runner against excessive cavitation or pitting for a period of one (1) year from date it is placed in service, or not to exceed two (2) years after completion and offer of shipment. The Contractor's guarantee of the runner against cavitation or pitting shall cover only normal turbine operation from one-quarter load up to safe cavitation limit, as established by the laboratory tests for the prevailing head and tailwater conditions.

Excessive cavitation or pitting of the runner shall be defined as the removal of 210 pounds of metal from the runner. Erosion, or damage caused by suspended matter in the water, or corrosion caused by the chemical composition of the water, are not intended to be covered by Contractor's guarantee.

19. DRAINS AND PUMPS. Two drainage sump pumps shall be provided in the bearing support section of the cover plate with discharge through a pipe going through the pit liner, and over the scroll case to the drainage tunnel below. Two motor-driven, self-priming vertical type pumps, complete with all necessary piping shall be provided for removing the turbine leakage water. One of the pumps shall be driven by a 50-cycle, 380-volt, alternating-current motor, and the other pump shall be driven by 250-volt, direct-current motor, power for which will be supplied from the station storage battery. Normally the water will be pumped by the alternating-current motor pumping unit, but the direct-current motor shall be arranged to start automatically, in the event of failure of the alternating-current motor pumping unit or excessive

rise of water in the sumps.

The sump pumps shall each be provided with suitable intake screens accessible for inspection and cleaning, and with float-operated switches so arranged that an alarm will sound when the second pump starts. The Contractor shall furnish all pipe, fittings, etc., within the turbine pit, including electric wiring, for complete drainage.

20. GAUGES, RELAYS, THERMOMETERS AND PIPING. The Contractor shall furnish the following accessories with each turbine:

(a) Dial indicator for shaft alignment, permanently mounted at the top of the bearing.

(b) Piezometer taps in speed ring vanes, together with piping and recording meter for recording the flow through the turbine. The recording meter shall be similar and at least equal to the Simplex Valve and Meter Company's Type MGO Meter Register, for indicating, recording and totalizing. The recording equipment will be calibrated during the field test.

(c) One standard 10-ohm temperature detector in each segment of the bearing, and one bearing temperature relay in the bearing so located as to indicate the hottest spot and with leads to a terminal board to be located in the turbine pit. The temperature detectors will be connected to temperature indicators to be furnished by the Purchaser. The temperature relays shall be similar and equal to the General Electric TYPE TB-2 which closes a pair of contacts when the temperature reaches approximately 105 degrees Centigrade.

The Contractor shall furnish the piezometers for turbine flow of standard iron pipe size brass piping, to be brought individually to the turbine floor level and provided with valves and caps.

Instrument Panel. All switches, relays, motor controls and all other electrical equipment for each unit, not specifically indicated to be mounted elsewhere, shall be mounted on an instrument panel to be furnished by others and installed on the turbine floor. Each Contractor shall furnish the specified equipment for his contract, all to match in appearance, as approved by the Engineer, to provide uniform appearance and operation.

21. LUBRICATION. The Contractor shall furnish a "one-shot" centralized lubrication system to lubricate all of the working parts of the turbine except the main guide bearing. This covers lubrication of the gate stem bearings (three per gate stem), gate shifting ring, servomotor connecting rods at the gate ring connection, and gate links.

The grease shall be distributed by two circular brass pipes, one mounted on the gate shifting ring, the other outside of the gate stem circle. Solid connections shall be used as far as practicable. The grease piping shall be carefully installed in order that there will not be possibility of any leakage or breakage. To this end, the piping system shall be tested under 1000 lbs. per square inch pressure.

The system shall be Farval Corporation's Dualine type or equal, as approved by the Engineer. The compressor shall have ample capacity for complete greasing three times a day for eight days. Compressor shall be furnished with a pressure gauge.

22. BOLTS AND NUTS. The parts of the turbine already installed, such as the throat ring support, speed ring, servo-motor bays in the pit liner, etc., having bolting flanges or pads with bolt holes tapped or threaded to standards other than those customarily used in the United States. Where the corresponding bolts, studs and nuts have been supplied with the installed parts for complete assembly with adjacent parts to be furnished under these specifications, such bolts, studs and nuts will be used and the Contractor shall design and drill adjacent bolt holes to match.

Where such bolts, studs and nuts are not available, or cannot be threaded or tapped by the Purchaser to match the tapped holes in the installed parts, the Contractor shall furnish the necessary bolts, or studs and nuts to U. S. Standards and the tapped holes in the installed parts will be drilled and re-tapped to suit.

All finished bolts, studs, nuts, screws, etc. necessary for assembly of the parts to be provided under these specifications shall be made in accordance with U. S. Standards.

Bolts and nuts shall be made of corrosion-resisting steel or bronze when subject to frequent adjustment or removal, such as adjusting bolts for gland rings of stuffing box, removable screens, strainers and adjustable bearings.

23. BOLT GUARDS. The Contractor shall provide suitable metal covers or protective screens at the coupling between sections of the turbine shaft and the revolving blade servo-motor and the generator shaft.

24. STAIRWAYS, PLATFORMS AND LADDERS. The Contractor shall furnish working, operating, and inspection platforms or walkways complete with stairs, hand-railing, floor plates and gratings where necessary in the turbine pit. All turbine pit equipment shall be easily removable for dismantling the turbine from above.

The floor around the head cover just above the bearing shall be grating with at least five removable sections as nearly equally spaced as possible to facilitate inspection of the bearing lubricating oil flow and of the head cover unwatering pumps.

Stairways and platforms to the generator thrust bearings are not included herein.

25. SPARE PARTS. The following spare parts shall be furnished:

1 - Main turbine guide bearing shell completely lined with babbitt metal.

4 - Wicket gates and stems completely machined.

4 - Gate stem levers.

24 - Breaking elements for gate operating mechanism.

1 Set - Gate stem bearing bushings.

1 - Complete set of packing

3 - Oil strainer screens.

All spare parts furnished shall be interchangeable with and of the same materials and workmanship as the corresponding parts of the turbine furnished under these specifications.

26. WRENCHES, TOOLS, LIFTING DEVICES, ETC. The Contractor shall furnish, with the turbine, all tools or other equipment that may be

required or convenient for assembling and dismantling of any part of the turbine, including attaching and removing the runner from the shaft. There shall also be included all bolts, studs, pressure grease fittings, lubricating devices, packing, gaskets and all other appurtenances that may be required to make the turbine a complete unit ready for operation. At least the following shall be furnished:

(a) A complete set of case-hardened wrenches and special tools mounted on a neat wood board with each item numbered or marked for ready identification.

(b) Cables for lifting gates, operating ring, blade servo-motor, runner, gate servo-motors, top plate, bottom plate, throat ring, shaft, bearing and gate mechanism, with necessary turnbuckles and shackles.

(c) Lifting device for runner, shaft and gates. Eye-bolts for blade servo-motor cylinder, for outer top plate, bearing, packing box and gate levers.

(d) One coupling bolt press.

Oil and Grease. The Contractor shall furnish the initial supplies of oil for filling the runner hub and for lubricating the guide bearing, plus 10 per cent additional of each, and sufficient grease for the grease lubrication system to provide for 3 months use.

27. SHOP ERECTION AND TESTS. The turbine, insofar as it is to be furnished under these specifications, shall be assembled in the shop and inspected for trueness of gate and blade movement, accuracy of closure contacts with adjacent gates and other features of mechanical accuracy in runner and shaft. Any imperfections shall be corrected and the turbine parts then doweled and match-marked to insure correct

assembly and alignment in the field, except for dowelings and fits to parts already installed in the field.

The runner hub, when completely assembled in the shop, shall be tested for oil tightness under double the pressure which exists under normal operation.

The servo-motor cylinders shall be tested under a gauge pressure of 450 pounds per square inch, using oil similar to that which will be used in operation.

28. PAINTING. All surfaces shall be thoroughly cleaned before applying paint or protective compound. Exposed unfinished surfaces of the turbine and accessories that are not to be in contact with water shall be given one shop coat of pure red lead and linseed oil paint prior to shipment. All such surfaces that will be in contact with water shall be given a shop coat of paint, of a type recommended by the manufacturer and approved by the Consulting Engineer. All finished surfaces shall be coated with a suitable rust-preventive compound. All surfaces subject to contact with lubricating or governor oil shall be painted with a special oil resisting enamel. All painting after erection will be done by the Purchaser.

29. OPERATING INSTRUCTIONS. The Contractor shall assemble parts catalogs and operating instructions for the turbine and governing equipment separately, which may be needed or useful in operation, maintenance and repairs, in suitable common cover, and shall furnish three copies of such assembled data and instructions.

30. DRAIN VALVE. The Contractor shall furnish one 30" hand-operated gate valve, outside screw and yoke type with iron body, bronze mounted, for draining the scroll case. Two conical make-up sections shall be provided to make up the one meter distance between flanges of the present installed piping. The two make-up sections shall be left blank and drilled in the field to the exact drilling of the 800 mm. diameter drain piping already installed. Bolts for connection to present drain pipe are at the site.

31. FIELD TESTS. Within six months after the turbine has been placed in operation, or not to exceed eighteen (18) months after completion and offer of shipment, the turbine and governor may be given such tests by and at the expense of the Purchaser as desired to determine whether the contract requirements have been fulfilled. In addition, efficiency and capacity tests, if desired by the Purchaser, may be made at his expense, at net effective heads, available at the time, between the operating limits of 16.7 meters (54.8 feet) and 32 meters (105 feet) net effective heads. Prior to the tests, the interior of the apparatus will be inspected by the Contractor and the Purchaser. Should such inspection disclose any damage or wear to have taken place that would impair the efficiency or capacity of the apparatus, the Purchaser will, at his own expense, restore such work or damaged parts as nearly as practicable to their undamaged condition.

Such tests will be conducted in accordance with the "Test Code for Hydraulic Prime Movers approved by Council, June, 1938", of the American Society of Mechanical Engineers.

GOVERNOR EQUIPMENT

32. GENERAL. The governor equipment for the turbine shall be the Woodward Governor Company's Cabinet actuator type. The governor equipment shall consist of an actuator unit, permanent magnet generator, two pumping units, sump tank, pressure tank, all piping and fittings, restoring rod mechanisms and all the necessary parts and accessories required to make a complete unit for regulating the speed and controlling the gate and blade operation of the turbine, except those parts specifically exempted herein.

The governing system shall be designed to operate at a maximum working pressure of 300 lbs. per square inch, and shall be guaranteed to safely withstand 450 lbs. per square inch test pressure. The system shall have adequate capacity to supply the necessary quantity of oil to the servo-motors to operate the turbine gates and the runner blades, from closed to full open or vice versa in 5 seconds at maximum operating head with a minimum pressure of 250 lbs. per square inch.

33. ACTUATOR AND CONTROLS. The speed responsive element of the actuator shall be driven by an alternating current motor receiving its power supply from a permanent magnet generator driven by the turbine. The speed responsive element shall be anti-friction type and shall be capable of causing the actuator to admit oil to the servo-motors for a corrective movement of the turbine gates in consequence of a speed variation of the turbine of one-fiftieth of one percent or less beyond the lap of the relay valve as determined by shop tests with pressure

gauges substituted for servo-motors. The speed of the responsive element shall vary directly with the speed of the main shaft of the turbine for all rates of acceleration and deceleration, including starting.

The actuator cabinet will be located on the generator floor, and shall be totally enclosed. All of the necessary valves to control the oil for the actuating mechanism shall be of the hydraulically operated type, incorporated as an integral part of the actuator unit and shall be controlled by a manually operated pilot valve mounted on the control panel. All mechanism necessary to permit automatic and manual hydraulic control of the oil pressure to the gate servo-motors and the blade servo-motor shall be included. The relay valve for gate control (and blade control) shall be of the oil pilot operated type.

All electrical control wiring within the actuator shall terminate in suitable terminal blocks, located within the actuator housing and readily accessible by steel doors in the housing. They shall be grouped on one side of the actuator and sufficient space shall be provided below these terminal blocks and within the housing to accomodate all incoming conduit. All control wiring within the actuator shall be color coded. It shall be neatly and properly supported and protected from abrasion where such may occur.

The relay operated oil pilot valve shall be connected in such a way that the operation of the overspeed trip on the main shaft will provide a complete shut-down of the unit after it has reached a pre-determined overspeed in case of failure of the permanent magnet generator or other controls.

The action of the governor in responding to and correcting speed changes shall be practically dead-beat and the governor shall operate without racing or hunting. The governor shall be capable of holding the speed of the unit governed as close as possible to normal when operating at any constant load within the capacity of the turbine, provided the voltage regulator is properly adjusted and there is no surging on the electrical end. The speed droop from no load to full load shall be adjustable from zero (0) upward.

The generator is being purchased with a flywheel effect of 36,000,000 lbs. $ft.^2$.

The governor shall be equipped with means for varying the rate of movement of the turbine gates for a range that may be found desirable under operating conditions from 5 seconds, per complete opening or closing stroke, upward.

Necessary auxiliaries shall be provided to permit control from the switchboard of the setting of the gate limit and speed adjustment, and indication of the gate position, gate limit, unit speed and instant of turbine break-away and final stopping of rotation. All switchboard instruments shall be Westinghouse Electric and Manufacturing Co. Type KA, 4" high by 4-1/4" wide, flush mounted, with white dials and black marking. All dials, gauges, and other instruments or controls mounted on the actuator cabinet shall be designed for flush mounting with flanges.

The front of the actuator shall form a panel on which the controls and instruments shall be mounted in a harmonious and workmanlike manner. The Contractor shall furnish the following controls and instruments and where so specified shall install them on the actuator.

(1) Gate Limit. A gate limit control device which can be operated manually at the actuator and also electrically from the switchboard by means of a 250-volt, direct-current, split-field motor, with suitable magnetic or friction clutch.

(2) Speed Level. A speed level controlling device which can be operated manually at the actuator and also electrically from the switchboard by means of a 250-volt, direct-current, split-field motor, with suitable magnetic or friction clutch.

(3) Automatic Shut-down. A device for closing and opening the turbine gates at the normal rate of movement which can be operated manually at the actuator, and with remote electrical closing control from the switchboard. The manual operation of this device shall require manual resetting at the actuator before the turbine gates can be reopened. This device will be used for automatic stopping of the turbine by means of the automatic protective features in connection with the main generator, governor equipment, or transformers. The shut-down solenoid shall be designed for continuous service at 250 volts, direct current, and to shut down the unit when energized.

(4) Speed Indicators. Two electrically operated speed indicators, one mounted on the actuator and one to be mounted by the Purchaser on the switchboard to indicate the speed of the turbine. A suitable magneto-type generator shall be included in the governor drive generator housing and shall be direct connected or geared to the governor generator shaft for operating the speed indicators of each unit. Each

speed indicator shall be provided with calibration adjustment. Suitable means for indicating turbine breakaway and final stopping of the unit shall be provided.

(5) Manual Control. Manual control of the turbine gates at the actuator by means of oil pressure from the governor oil pressure system. The transfer from actuator to hand control and vice versa shall be as convenient as possible.

(6) Pressure Gauge. A duplex pressure gauge mounted on the actuator, graduated in pounds per square inch, for indicating the air pressure in the air system and also in the generator brake cylinders.

(7) Pressure Gauges. A combination electrical gauge to indicate the oil level and pressure in the governor oil pressure tank, to be installed on the switchboard; and a gauge to indicate the oil pressure, mounted on the actuator.

(8) Position Indicators. A gate-limit indicator and gate-position indicator of the dual type for mounting on the main control board and a similar instrument to be mounted on the actuator. Each instrument shall be of a type and size approved by the Engineer and shall indicate the position of the governor gate-limit device and the position of the turbine gates.

A dial indicator mounted on the actuator to show the position of the blades.

(9) Overspeed Switch. An overspeed switch mounted on and forming part of the governor drive generator, arranged to shut down the turbine and to sound an alarm upon overspeed. Three pairs of 1.5

ampere, 250-volt, direct-current, ungrounded contacts shall be provided, changeable from circuit opening to circuit closing as desired. These contacts shall be adjusted to operate at any speed from 125 percent of normal to a speed higher than the maximum speed the turbine can develop with loss of full load, under governor control, with any adjustment of rate of gate movement specified herein. The contacts shall reset automatically at 115 percent of normal speed. The alarm will be furnished by the Purchaser.

(10) Speed Droop. A device for controlling the speed droop of the turbine, which can be operated manually at the actuator. The amount of speed droop shall be adjustable from zero to 5 percent. The design of the speed-droop control mechanism shall be such that it will be possible to adjust it so as to secure the most efficient division of load between this turbine and the similar turbines to be installed in the future, and between this and interconnected power plants according to their individual characteristics and the load requirements of the system.

(11) Auxiliary Switches. Five independent auxiliary switches operated from the turbine-gate motion. Each switch shall be adjusted to close or open its contacts at any point from zero to three-tenths gate opening, as desired. The contacts shall be ungrounded and suitable for interrupting 1.5 amperes at 250 volts, direct current.

(12) Air Valve. A combination automatic and hand-operated air valve for controlling the operating of the generator brakes. The air valve shall be arranged so that the brakes cannot be applied until the turbine gates are fully closed and the generator disconnected from

the line. When operated automatically the brake application shall in addition be deferred until the unit speed has decreased to approximately 20 revolutions per minute. The operations of the automatic air valve shall be initiated by means of a control switch on the actuator with manual and automatic operating positions. The switch shall be spring-return to "off" from the "manual" position and maintaining in the "automatic" position. When on the "manual" position, the switch shall control the air-brake valve directly. When on the "automatic" position, the switch shall control the air-brake valve through a timing device to cause intermittent brake application with time periods adjustable. The brakes shall be released after an adjustable period of time sufficient to assure that the unit has been brought to a complete stop. An indicating lamp shall be lighted on the switchboard when the control switch is on the "automatic" position. The hand control shall be adequate for operating the valve when the solenoid for the automatic operation is energized and shall be provided with a spring-loaded, hand-grip release to break the electrical circuit.

(13) Pressure Switch. A pressure switch with an adjustable 1.5-ampere, 250-volt, direct-current, ungrounded contact to close an alarm circuit when the governor oil pressure drops to a pre-determined value. The alarm will be furnished by the Purchaser.

(14) Pressure Switch. A pressure switch with an adjustable 1.5-ampere, 250-volt, direct-current, ungrounded contact to open on extremely low governor oil pressure, for use as a starting interlock.

(15) Provision for Speed Matching. Provisions for later

installing a device for automatically matching the speed of the turbine with the speed of the system, to be used in conjunction with automatic synchronizing equipment furnished by the Purchaser.

(16) Low-speed Switch. A low-speed switch mounted on and forming a part of the governor-drive generator, arranged to close the automatic-air-valve circuit when the speed of the unit is less than 20 revolutions per minute. A 250-volt, direct-current, ungrounded contact is desired, having sufficient capacity for the air-brake control circuit.

(17) Penstock Pressure Gauge. A gauge to show the penstock pressure in kilograms and the head in meters.

34. PERMANENT MAGNET GENERATOR. The permanent magnet generator, to supply current to the governor head motor, shall be direct-connected through a dry type flexible coupling to the shaft of the exciter or pilot exciter. The generator contractor will design the frame of the exciter and the exciter shaft to provide suitable mounting and drive for the permanent magnet generator.

The enclosure for the permanent magnet generator shall contain the direct-connected overspeed and underspeed switches and the magneto-type speed indicator generator hereinbefore specified.

35. GOVERNOR OIL PUMPS. The governor shall be provided with two motor-driven oil pumps of the rotary or screw type, having a combined capacity per minute of 3-1/3 times the total volume of the servo-motors of the turbine for usual or "regular" operation, and an additional

"reserve" pump of the same size as one of these pumps to serve as a replacement in case of breakdown. The pumps shall be mounted on the sump tank, suitably isolated to minimize vibration and noise.

The pumps shall be self-priming under the maximum oil pressure. The motors shall be direct connected to the pumps and shall be 3 phase, 50-cycle, 380 volt, squirrel cage, low-starting current, induction type, 40-degree Centigrade temperature rise, designed for full voltage starting and conforming to the standards of the National Electric Manufacturers' Association and the American Standards Association. The motors shall have ball bearings and closed conduit boxes and the windings shall have moisture- and oil-resistant insulation.

Automatic controls which will start the pumps when the oil pressure in the pressure tank drops to a pre-determined point and which will stop the pumps when the oil pressure rises to a pre-determined point shall be furnished with the pumping units. Suitable terminal blocks with marking strips shall be provided in accessible places for the control wiring. The starting equipment shall be arranged so as to start the motors and permit them to reach full speed before the pumps load and to unload the pumps before the motors are disconnected from the power supply.

The two governor oil pumps for "regular" operation shall be inter-connected so that they can be operated independently or together. The "reserve" pump shall be interconnected so that it can be substituted for either of the two regularly operated pumps. The connections of each pump shall be so arranged that the pump may be disconnected, removed for repair, and replaced without interfering with the continuous operation of the other pump operating in parallel with it. When operating together, the interconnection and automatic control of the two "regular" pumping units shall be such that either pumping unit may be used for normal operation, with the other unit serving as a stand-by unit, arranged to start automatically either on failure of the electric power supply to the operating pump or upon the oil pressure falling below a pre-determined amount. The stand-by pump shall then start automatically and deliver oil to the pressure system. Each pumping unit shall be provided with an unloader valve, check valve, safety valve, and a suitable number of hand-operated valves in the suction and discharge pipe lines so as to constitute a complete unit with the minimum number of flanged or screwed connections. The unloading valve, safety valve, and starting and stopping pressure relays shall be accurately set and tested in the Contractor's shop for running conditions. Magnetic starting contactors with disconnecting switches and protective relays shall be furnished by the Contractor and shall be mounted on or adjacent to the pumping units.

36. PRESSURE TANK. The pressure tank will be located on the turbine floor. The pressure tank shall be of welded construction, constructed and tested in accordance with paragraphs U-69, U-76, U-77 and other applicable paragraphs of the A.S.M.E. Code for Unfired Pressure Vessels, Section VIII. The circumferential and longitudinal joints shall be ground smooth. The tank shall have a capacity of not less than 20 times the volume of the servo-motors of the turbine, and shall contain 5 volumes of oil and 15 volumes of air at maximum working pressure.

The pressure tank shall be provided with a manhole and equipped with a sight gauge to indicate the elevation of the oil level in the tank and with a manually operated air blow-off valve. The oil level gauge glass shall be protected from accidental breakage by means of suitable guards and shall be provided with both hand shut-off valves and automatic means of shutting off air and oil discharge from the pressure tank in the event of breakage of the gauge glass.

All connections to the pressure tank, except the air blow-off, the connection to air compressor and the upper gauge glass connection, shall be made below the low oil level. Provisions shall be made so that the oil level cannot fall so low as to admit air from the upper part of the tank into the oil piping system. By-pass valves shall be provided to drain the pressure tank into the sump for cleaning or repairs.

37. SUMP TANK. The sump tank shall have a capacity of not less than 110 percent of the total quantity of oil in the entire governor system. The sump tank shall be provided with a manhole for access to the interior of the tank and with an easily removable strainer through which all oil returned from the servo-motors shall pass. The sump tank shall be provided with an oil-level gauge for indicating the quantity of oil in the tank, a drain connection for draining the tank, and suitable connections for an oil purifier to be furnished by the Purchaser.

38. PIPING. The Contractor shall furnish all necessary oil piping, fittings and valves for the governor system. Connections shall

be provided for interconnecting piping for the future units. The piping shall be of such size that the maximum velocity of the oil shall not exceed 4.5 meters (15 feet) per second. The piping shall be seamless, iron-pipe size, steel tubing, and all pressure pipe larger than 5 cm. (2") in diameter shall be provided with extra heavy steel Van Stone or equal flanges. The low pressure piping may be provided with standard cast-iron flanges. Whenever feasible to do so, long radius pipe bends shall be used in lieu of pipe fittings. Only such flanged connections shall be provided as may be necessary for shipment and erection, or subsequent dismantling for repair. The entire piping system shall be fusion welded insofar as practicable, in accordance with the American Standards Association Code for Pressure Tanks, applicable paragraphs of Section 5, Chapter 3. The piping shall be cut to length and fitted with flanges and thoroughly cleaned and protected, as hereinafter specified.

All valves except valves built in and forming an integral part of the governor or pumping units shall be of the rising stem, steel-body, bronze-mounted type. All gate valves in the pressure lines shall be 300-lb. standard, cast-steel, solid-wedge type and shall have close guide clearance so as to minimize vibration of the gates when operating under pressure and at partial opening.

The ends of sections of piping shall be capped with standard blind flanges and gaskets to exclude dirt and moisture in transit and to protect the finished faces of the flanges. All necessary studs, bolts, nuts, washers, gaskets, packing, etc., required in field assembly of the governor oil-piping system shall be furnished.

39. RESTORING CONNECTIONS. The restoring connections between the actuator and gate servo-motors and between the actuator and runner blade control head shall be of the pre-formed aviation cable type, weight loaded on the actuator end. The cable shall be fastened to the piston rod or trunk piston of the servo-motor by means of a connection provided by the turbine contractor. The cable shall be supported on grease-packed, ball-bearing sheaves and completely enclosed in a grease-tight metal housing. Provision shall be made for taking up any stretch in the cable. Straps and U-bolts shall be furnished for clamping the metal housings of the restoring connections to the piping. After the restoring connections have been assembled permanently in the field, the connection will be filled with grease to make the entire connection self-lubricating.

40. AIR COMPRESSOR. An air compressor for make-up air for the governor system shall be provided with the governor. The unit shall have a piston displacement of not less than 200 cu. decimeters per minute at 21 kilograms per sq. cm. pressure (7 C.F.M. at 300-lb. pressure). The compressor unit shall be an air-cooled, two-stage, V-belt, motor-driven unit with compressor and motor mounted together on an integral base. Power for the motor will be 3 phase, 50-cycle, 380 volt. Suitable manual starter similar and equal to Westinghouse "Sentinel Breaker", and intake filter and muffler shall be furnished.

41. WRENCHES AND TOOLS. A complete set of any special tools, which may be necessary or convenient for assembling and dismantling the governor, shall be provided. The tools shall be mounted on a neat hard-

wood board with each item marked for ready identification.

42. SHOP ERECTION AND TESTS. The governor and auxiliary equipment shall be completely assembled in the Contractor's shop and tested insofar as practicable. The pressure tank shall be subjected in the shop to a hydrostatic test of 450 pounds per square inch. The low-pressure oil sump shall be tested for leaks by means of hot oil before any painting is done. Various parts shall be properly match-marked and doweled to insure correct assembly and alignment in the field. The entire system subject to governor oil pressure will be tested after erection in the field under a pressure 50 percent above the maximum working oil pressure and must be capable of safely withstanding the test pressure.

The unit shall be shipped complete and ready for operation with the exception of the external piping. Field testing after erection will be done by the Purchaser to determine whether the equipment meets these specifications and the guarantees of the Contractor.

43. PAINTING. The interior surfaces of the pressure and sump tanks shall be carefully sand- or shot-blasted, and then immediately painted one coat of Lilly Varnish Company's Special Oil Proof Enamel, or other suitable coating, to prevent deterioration of the metal. The inside of any piping permanently attached to the tanks shall be painted the same as the tanks.

The exterior surfaces of the pressure and sump tanks shall be cleaned by sand-blasting and then filled, primed and finished as hereinafter specified for the actuator.

The actuator cabinet shall be completely painted by the Contractor in the shop. It shall be thoroughly cleaned, and given one primer coat, an application of machine filler to fill or patch all holes, pits and defects, a sealer coat of rust-inhibitive paint, (being sanded and rubbed smooth after the filler and seal coats), and then enameled to "cabinet finish" with two coats of oil-proof machine enamel of color as directed.

The inside and outside of the piping shall be sandblasted and then, immediately after cleaning and before corrosion can commence, the interior surfaces shall be given a coat of Potomac Chemical Company's Tectyl #506 Rust Preventive, or other equal and approved. The exterior surfaces of the piping and all other exposed unfinished surfaces of the governor equipment shall, after cleaning, be given one shop coat of pure red lead and linseed oil paint.

All finished surfaces shall be coated with a suitable rust-preventive compound. All surfaces which will be embedded in concrete shall be cleaned and left unpainted. All painting after erection will be done by others.

44. SUPPLY OF OIL. An initial supply of oil for the entire governing system, plus 10% additional, shall be furnished, - to be one of the following oils or other equal and approved:

Texas Company - Alcaid
Gulf Refining Company - Paramount "A"
Pure Oil Company - Puritan Turbine Oil (Heavy Medium)
Standard Oil of Indiana - Non-Pareil Turbine Oil

45. SPARE PARTS. The following spare parts shall be furnished:

(a) 1 - Pilot valve bushing and plunger.

(b) 1 - Relay valve bushing and plunger.

(c) 1 - Complete governor head, including motor stator and rotor.

(d) 1 - Governor dashpot assembly.

(e) 1 - Governor-head-drive generator stator and rotor.

(f) 1 - Complete set of packings.

All spare parts shall be interchangeable with and of the same materials and workmanship as the corresponding parts of governing equipment furnished under these specifications.

46. ARTICLES TO BE FURNISHED BY OTHERS. The Purchaser will furnish the following:

(a) Oil storage tanks, oil filtering system and all piping and fittings incident thereto.

(b) Air lines from compressor to pressure tank and to air brake valves.

(c) Air lines from actuator to generator air brake cylinders.

(d) All external wiring and conduits.